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No. 80-2037

IN THE

Supreme Court of the United States

OCTOBER TERM, 1980

JIMMY R. COLE, d/b/a JIM R. COLE &
ASSOCIATES and COLE DEVELOPMENT
COMPANY, INC.,
Petitioners,

versus

CONTINENTAL OIL COMPANY,
Respondent.

PETITION FOR A WRIT OF CERTIORARI TO THE UNITED STATES COURT OF APPEALS FOR THE FIFTH CIRCUIT

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QUESTIONS PRESENTED

1. Whether the complained of judgment of the Court of Appeals holding valid a patent and finding a sole distinguishing feature based on a rotatable connection of a depth controller to a cable, when such a rotatable connection was known in the prior art, is in conflict with recent decisions of this Court involving patent validity under the "obviousness" test of 35 U.S.C. § 103.

(a) A prior patent discloses each feature of the claims of the patent in suit except a rotatable connection of the depth controller to the cable. However, this feature was old and known in the art. The combination of these known features resulted in no effect greater than the sum of prior art effects taken separately. Despite such absence of a synergistic result, the Court of Appeals held the patent in suit non-obvious over the prior art.

(b) The test of obviousness used by the Court of Appeals focused on the "subject matter as a whole" under which virtually all combinations of elements would be subject to patent monopoly, and not the test of "obviousness" of bringing the elements together used by this Court.

2. Whether the complained of judgment of the Court of Appeals is in conflict with decisions of this Court, in holding that proof of satisfactory testing by others under normal service conditions, prior to the work leading to the patent in suit, is not a sufficient showing of priority of invention to constitute either "prior art" under either 35 U.S.C. 102(g) or 35 U.S.C. 103, or an indicia of obviousness under 35 U.S.C. 103.

(a) Prior to the alleged invention of the patent in suit, others in the art built depth controllers rotatably attached to a cable. When tested, the controllers had some problems under abnormal operating conditions, but performed satisfactorily under normal operating conditions. Such prior work of others was disregarded by the Court of Appeals as prior art and even as indicia of obviousness of the patent in suit.

(b) The Court of Appeals ruling requires a far greater level of completion of earlier work of others in order for such work to be considered in testing the validity and the scope of patent monopolies than prior decisions of this Court have done.

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No. ____________

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JIMMY R. COLE, d/b/a JIM R. COLE &
ASSOCIATES and COLE DEVELOPMENT
COMPANY, INC.,
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versus

CONTINENTAL OIL COMPANY,
Respondent.

PETITION FOR A WRIT OF CERTIORARI TO THE UNITED STATES COURT OF APPEALS FOR THE FIFTH CIRCUIT

Petitioners, Jimmy R. Cole and Cole Development Company, Inc. pray that a writ of certiorari issue to review a judgment and opinion of the United States Court of Appeals for the Fifth Circuit entered January 12, 1981. Timely Motion for Rehearing was denied February 12, 1981.

CITATIONS TO THE RECORD AND OPINIONS BELOW

The opinion of the Court of Appeals is reported at 634 F.2d 188 and is reproduced at Appendix A hereto. The District Court opinion is unreported but is reproduced at Appendix B hereto. Denial of Defendants' Motions for Rehearing is reported at 638 F.2d 1234 and is reproduced at Appendix C hereto.

GROUNDS FOR JURISDICTION

The judgment of the Court of Appeals for the Fifth Circuit was made final by the decision rendered January 12, 1981, and Petitioners' Petition for Rehearing was finally denied by that Court on February 12, 1981. The jurisdiction of this Court is invoked under 28 U.S.C. § 1254(1), and Rule 19, Revised Rules of The Supreme Court of the United States.

THE LAW INVOLVED

The law involved includes 35 U.S.C. § 102(g) and 103 which provide, as applicable here, as follows:

> 35 U.S.C. 102:
>
> "A person shall be entitled to a patent unless—
> (g) before the applicant's invention thereof the invention was made in this country by another who had not abandoned, suppressed, or concealed it."
>
> 35 U.S.C. 103:
>
> "A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter as a whole would have been obvious at the time the invention was made

> to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made."

STATEMENT OF THE CASE

Plaintiff sued Defendants for infringement of its United States Patent No. 3,375,800, "Seismic Cable Depth Control Apparatus" (Appendix D) (hereafter '800 patent). Jurisdiction in the Trial Court was based on 28 U.S.C. § 1338. The Trial Court in an unreported decision (App. B) construed Plaintiff's patent claims in such a manner that they were not infringed by Defendants' cable depth controllers. Both Plaintiff and Defendants appealed. The Fifth Circuit Court of Appeals (App. A) reversed the Trial Court's finding of non-infringement and held the '800 patent valid and infringed.

The '800 patent, the validity of which is in question in this action, relates to a depth controller or paravane for a seismic cable used in exploration for submerged petroleum formations. Claims 1, 2, 4, 22 and 25 are alleged to have been infringed by Defendants. Claim 1 is exemplary and reads as follows:

> 1. A paravane for a seismic cable adapted to be towed substantially horizontally through water, comprising:
>
> a housing having a bore means along its length thereof, said bore means of a size to receive said seismic cable and allow rotation of said seismic cable without rotation of said housing while transmitting upward and downward forces between the housing and the adjacent portions of said cable;

> bearing means for securing the housing onto said seismic cable against movement of said housing along said cable; and
>
> means carried by the housing including at least one vane for maintaining the paravane at a predetermined depth in the water as the paravane is moved through the water by the cable and for counteracting upward, downward and turning forces imposed on the housing, whereby the paravane maintains the adjacent portions of the said seismic cable at said predetermined depth.

At trial, Petitioners relied on U.S. Patent No. 3,372,-666, "Depth Controller", (hereafter the Baker patent) (Appendix E) and a prior working device built in 1965 by the inventor of the Baker patent as prior art which invalidated Respondent's patent claims under 35 U.S.C. § 102(g) and 103.

The Trial Court gave a restricted interpretation to Respondent's patent claims in view of the Baker patent and working device and thus did not reach the issue of patent validity of Respondent's patent.

On appeal, Respondent's '800 patent was held valid under 35 U.S.C. § 103 over the Baker '666 patent because the Baker *patent* did not teach utilization of a simple rotatable connection to connect the depth controller to the seismic cable. Further, the Court of Appeals disregarded the Trial Court findings that Baker's prior documented research in 1965 (Appendix F) had developed an operational cable depth controller and thus a "working device" in which such a simple rotatable connection was in fact used to rotatably attach a depth controller to a seismic cable.

The opinion of the Court of Appeals did not mention, and therefore apparently did not consider, another prior art patent also relied upon by Petitioners at trial and on appeal (Reid—U.S. Patent No. 2,607,842), (Appendix G) which shows in Fig. 9 a rotatable connection of a cable depth controller to a seismic cable. As described in the Reid patent, the structure shown in Fig. 9 of its drawings provides:

> "A simple and effective device for connecting the [seismic] cable 23 and the float 33 *while permitting free rotation of the cable* . . ." [Emphasis Added.]

The Reid patent was cited and discussed with respect to this exact Fig. 9 in the Conoco '800 patent file history. Thus, the Patent Office Examiner could not have based allowance of the Conoco '800 patent on the lack in the prior art of a rotatable connection of a depth controller to a cable.

The Court of Appeals decision, however, is premised on the basis that it would not be obvious to one of ordinary skill in the art to incorporate a rotatable connection of a depth controller to a seismic cable, as was known from the prior art Reid patent as well as the prior working device of Baker, which was built and tested in the Gulf of Mexico by Texas Instruments Incorporated.

REASONS WHY THE WRIT SHOULD BE GRANTED

The writ should be granted because (1) interpretation of an important Federal Statute involving the validity of patents is at issue and (2) the judgment of the Court of Appeals in this case is in conflict with and is contrary to the decisions of the Supreme Court in the following cases: *Sakraida v. Ag-Pro Inc.,* 425 U.S. 273 (1976); *Anderson's-Black Rock, Inc. v. Pavement Salvage Co.,* 396 U.S. 57 (1969); *Graham v. John Deere Co.,* 383 U.S. 1 (1966); *United States v. Adams,* 383 U.S. 39 (1966) and *Great Atlantic & Pacific Tea Co. v. Supermarket Equipment Corp.,* 340 U.S. 147 (1950).

Each of the above decisions of this Court, with the exception of the *Adams* case involving battery chemistry, has dealt with the standard of validity under the patent laws for patents involving combinations of known, old mechanical elements, of the type of Respondent's '800 patent in suit here.

The Court of Appeals in dealing with obviousness did not, however, utilize the standard of patentability enunciated by this Court in these cases. Rather, the Court of Appeals in its opinion quoted with apparent approval the following language from *Adams v. United States,* 330 F.2d 622, 625, 165 Ct. Cl. 576 (1964), a Court of Claims case:

> "While the use of any of the individual components . . . may have been obvious at the time of the invention, the invention *as a whole* was not obvious. . . ." *Continental Oil Co. v. Cole,* supra, at 634 F.2d 197.

The *Adams* opinion of the Court of Claims cited by the Court of Appeals was reviewed by this Court. *U.S. v. Adams,* 383 U.S. 39. This Court, on review of *Adams,* used a different standard of patent validity than that adopted by the Fifth Circuit in the opinion sought to be reviewed here. In *Adams,* this Court enunciated the test as follows:

> "If such a combination is novel, the issue is *whether bringing them together* as taught by Adams *was obvious in the light of the prior art.*" *Adams,* supra, 383 U.S. at 50. [Emphasis added.]

The opinion sought to be reviewed here simply did not recognize the existence of, or use, this standard enunciated by this Court.

Further, the *Adams* decision was handed down the same day as *Graham v. John Deere Co.,* supra. In *Graham,* this Court in dealing with the patentability of an invention under 35 U.S.C. § 103 indicated that the test to be applied was "the obviousness of the differences," 383 U.S. at 23, between a patent and the prior art. In *Graham,* this Court held that the alleged "crucial difference" of the patent in question over the prior art, improved plow shank flexing, was obvious to a person of ordinary skill in the art, even though no prior art was referred to which showed this specific feature contended to be the non-obvious difference of the patent in question over the prior art. In the present case, an even clearer case of obviousness under 35 U.S.C. § 103 is present, since the allegedly unobvious difference in the Conoco '800 patent of rotation was disclosed in the prior Reid patent (App. G) and was known to others in the art (App. F).

More recent decisions of this Court since the *Graham* and *Adams* cases, *Anderson's-Black Rock v. Pavement Salvage Co.,* 396 U.S. 57 and *Sakraida v. Ag-Pro, Inc.,* 425 U.S. 273 have adhered to the *Graham* analysis and held invalid patents on combinations of known mechanical elements, as is the case here.

> "Rather, this patent simply arranges old elements with each performing the same function it had been

> known to perform, although perhaps producing a more striking result than in previous combinations. Such combinations are not patentable under standards appropriate for a combination patent." *Sakraida,* supra, 425 U.S. at 282.
>
> "We conclude that while the combination of old elements performed a useful function, it added nothing to the nature and quality of the radiant-heat burner already patented. We conclude further that to those skilled in the art the use of the old elements in combination was not an invention by the obvious-non-obvious standard." *Anderson's-Black Rock,* supra, 396 U.S. at 62-3.

Thus, the Court of Appeals in this case has departed from firmly established standards of patentability under 35 U.S.C. 103 enunciated over the years by this Court.[1]

The Court of Appeals in the judgment complained of was apparently swayed by Respondent's commercial success in its finding of non-obviousness of the present invention:

> "Within a short time after the paravanes became available a majority of the marine crews throughout the world were using them, including the crews of some of the largest companies." 634 F.2d at 192.

---

[1] Indeed, one of these cases from this Court on the issue of obviousness under 35 U.S.C. § 103 is a reversal of the Court of Appeals for the Fifth Circuit, *Sakraida v. Ag-Pro,* supra. Not only is the Fifth Circuit contrary to the Supreme Court in *Sakraida,* but it failed to even consider the lack of synergistic effect. On that issue, the circuit courts are in conflict and need guidance from the Supreme Court. For example, *Smith v. Acme General Corp.,* 614 F.2d 1086 (6th Cir. 1980), *Reinke Mfg. Co. v. Sidney Mfg. Corp.,* 594 F.2d 644 (8th Cir. 1979) and *Tveter v. AB Turn-O-Matic,* 633 F.2d 831 (9th Cir. 1980) require a synergistic effect. *Republic Industries, Inc. v. Schlage Lock Co.,* 592 F.2d 963 (7th Cir. 1979) and *Plastic Container Corp. v. Continental Plastics,* 607 F.2d 885 (10th Cir. 1979) do not.

This Court in *Sakraida*, supra, specifically pointed out the danger of letting commercial success become the touchstone for patent validity in determining non-obviousness under 35 U.S.C. § 103:

> "Though doubtless a matter of great convenience, producing a desired result in a cheaper and faster way, and enjoying commercial success, [the patented device] 'did not produce a "new or different function" . . . within the test of validity of combination patents.' [citing cases] These desirable benefits 'without invention will not make patentability.' " 425 U.S. at 283-284.

Thus, it is respectfully submitted that the Court of Appeals' opinion subordinates Supreme Court law, by treating the commercial success of Respondent's device as a basis for non-obviousness over the prior art under 35 U.S.C. § 103. Further, the opinion of the Court of Appeals is reached without applying, or even recognizing, the tests enunciated by this Court in *Graham v. John Deere* and *Adams*. The test of *Graham* is whether a *difference* over the prior art Baker '666 patent of a "rotatable seismic cable" would have been obvious to a person of ordinary skill in the art, in view of that feature having been shown in the prior art Reid patent (App. G) and tested and documented (App. E & F) by prior workers in the art.

The Court of Appeals' opinion also did not regard the Baker patent disclosure instruction and cover sheet or the research work of Mr. Baker either as prior art or in terms of its evidentiary effect on the issue of "obviousness".

The Court of Appeals' opinion appears to be premised on the erroneous view of the law that a commercially marketable device must be developed before a prior invention by another constitutes prior art. Such a view of the law is contrary to Supreme Court law, *Corona Cord Tire Co. v. Dovan Chemical Corp.*, 276 U.S. 358 (1928):

> "This work was finally recorded in a carefully prepared contemporaneous report which Kratz left in the files of the Norwalk Company . . ." *Id.* at 379.
>
> "But, even if we ignore this evidence of Kratz's actual use . . . what he did . . . leaves no doubt in our minds that he did discover in 1916 the strength of D.P.G. as an accelerator as compared with the then known accelerators, and that he then demonstrated it by a reduction of it to practice in production of cured or vulcanized rubber.
>
> "This constitutes priority in this case." *Id.* at 382.

As another decision of this Court applied the test:

> "It is not necessary, in order to sustain a generic patent, to show that the device is a commercial success. The machine patented may be imperfect in its operation; but if it embodies the generic principle and works, that is, if it actually and mechanically performs, though only in a crude way, the important function by which it makes the substantial change claimed for it in the art, it is enough." *Hildreth v. Mastoras,* 257 U.S. 27, 34 (1921).

The Court of Appeals' opinion, if allowed to stand, would create a situation in the patent law where earlier research results of others, in order to be considered as "prior art" under 35 U.S.C. 102 and 103, would have to be put into a commercially marketable form. Under the Court of Appeals' opinion, such research results could not be relied upon as prior art by an accused infringer in an action for patent infringement unless they culminated in a commercial product. The Court of Appeals' opinion thus greatly circumscribes the ambit of activities available as prior art in a defense to a patent infringement action and considerably expands the scope of a patentee's monopoly by claim interpretation.

The Fifth Circuit opinion can be argued to be deliberately and intentionally in direct conflict with prior opinions of this Court. The Petition for a Writ of Certiorari therefore should be granted so that this Honorable Court can correct these errors on the part of the Court below.

CONCLUSION

For the reasons set forth above, it is respectfully submitted that this Petition for a Writ of Certiorari should be granted.

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CERTIFICATE OF SERVICE

I hereby certify that a copy of the above and foregoing Petition has this date been served upon opposing counsel of record by placing same in the United States Mail, postage prepaid and properly addressed.

May ______, 1981.

ALBERT B. KIMBALL, JR.

APPENDIX

APPENDIX A

> ranted consistency in the sentencing judge's past treatment of selective service offenders. Similarly, in *United States v. Baker, supra*, this court examined the records of the district court in an attempt to uncover a mechanical attitude toward sentencing on the part of the district judge. 487 F.2d at 361 n.1.

500 F.2d at 1354. *See also United States v. Foss*, 501 F.2d 522, 529 (1st Cir. 1974) (court considered sentencing judge's record in other cases, but concluded that it was insufficient to prove "a policy of any particular type.").

Recalling the posture of this case, that appellant's § 2255 motion has been denied without a hearing, and recalling the standard that an evidentiary hearing is required unless the record shows conclusively that petitioner is entitled to no relief, we conclude that appellant has made a showing sufficient to entitle him to an evidentiary hearing on the issue raised by the alleged predetermined sentencing policy. Accordingly, we reverse and remand for a hearing on this issue.

AFFIRMED IN PART, REVERSED IN PART, AND REMANDED.

CONTINENTAL OIL COMPANY, Plaintiff-Appellant, Cross-Appellee,

v.

Jimmy R. COLE, d/b/a Jim R. Cole & Associates and Cole Development Co. Inc., Defendants-Appellees, Cross-Appellants.

No. 78-1961.

United States Court of Appeals,
Fifth Circuit.

Jan. 12, 1981.

Rehearing and Rehearing En Banc
Denied Feb. 12, 1981.

Plaintiff appealed from a determination of the United States District Court for the Southern District of Texas, at Houston, Robert O'Conor, Jr., J., that its patent for a seismic cable depth-controlling paravane was not infringed by a device patented by defendant. Defendant cross appealed, challenging the validity of plaintiff's patent. The Court of Appeals, Politz, Circuit Judge, held that: (1) plaintiff's patent No. 3,375,800 for a seismic cable depth-controlling paravane was valid; the paravane was neither anticipated by the prior art nor were the claims obvious to one ordinarily skilled in the art; (2) the creative process existing prior to issuance of plaintiff's patent was in an embryonic stage, and it would be manifestly unjust to characterize said patent as anything other than innovatively different and not readily obvious to a person of ordinary skill in the field of marine seismology; (3) defendant's accused device infringed the range of equivalents of plaintiff's patent; and (4) the doctrine of file wrapper estoppel was inapplicable.

Reversed, rendered and remanded.

1. Patents ⇐324.55(1, 3)

The sine qua non of appellate review of patent litigation is the notion that validity and interpretation are legal questions based upon factual inquiries.

2. Federal Courts ⇐754

When confronted with pure questions of law, the Court of Appeals is free to examine the district judge's answers and correct any error or oversight; in contrast, factual questions resolved by the trial court warrant deference, and reversal is mandated only if the findings are clearly erroneous. Fed.Rules Civ.Proc. Rule 52(a), 28 U.S.C.A.

3. Patents ⇐324.5

Although infringement normally is a fact question, legal questions of construction can become so intertwined that the clearly erroneous standard of review applicable to a pure fact finding must yield. Fed.Rules Civ.Proc. Rule 52(a), 28 U.S.C.A.

4. Patents 🔑226.5

One form of patent infringement occurs when an accused device incorporates a teaching literally read.

5. Patents 🔑237

An infringement occurs when a device appropriates a prior invention by incorporating its innovative concept and, albeit with some modification and change, performs substantially the same function in substantially the same way to achieve substantially the same result; the "doctrine of equivalents" shields the inventor from such abuse.

6. Patents 🔑237

Determination of equivalency involves an examination of the scope of prior art, the essence or "heart" of the invention disclosed, and the step forward the invention offers.

7. Patents 🔑173

A pioneer or generic patent which opens a new path is entitled to broader protection than a patent which merely improves upon that which is already known.

8. Patents 🔑168(2), 237

Ambit of equivalency is limited by the claims as made, amended or surrendered in the process which makes up the "file wrapper" and grounds the defense of "file wrapper estoppel."

9. Patents 🔑324.56

While the trial court's findings, in patent infringement suit, were in the main conclusory, and while the Court of Appeals, in this situation, routinely would remand for more specific findings, the nonspecificity of the findings in the instant case was merely a hindrance and not a fatal error, since the evidence was such that without weighing the credibility of the witnesses there could be but one reasonable conclusion as to the result.

10. Patents 🔑314(2)

Determination of the validity of a patent should not be sidestepped for convenience by addressing only the infringement issue when the question of validity is raised.

11. Patents 🔑226.5

In patent validity and infringement litigation, the task of discerning reticent dissimilarities is as imperative as noting the more visible similarities.

12. Patents 🔑328(2)

Plaintiff's patent No. 3,375,800 for a seismic cable depth-controlling paravane was valid; the paravane was neither anticipated by the prior art nor were the claims obvious to one ordinarily skilled in the art. 35 U.S.C.A. §§ 102(a, e), 103.

13. Patents 🔑51(1)

Not only is the defense of anticipation strictly a technical one, but also there is no anticipation unless all of the same elements or their equivalents are found in substantially the same situation where they do substantially the same work in the same way.

14. Patents 🔑66(1.20)

Plaintiff's patented device, a seismic cable depth-controlling paravane, was a breakthrough in the seismic industry and was not precursored by the working model of another's cited invention and its progeny. 35 U.S.C.A. § 102(a).

15. Patents 🔑112.1

A presumption of validity arises from the issuance of a patent, and this is especially so in a case where the same patent examiners simultaneously review the allegedly contending applications.

16. Patents 🔑112.1

If there is no evidence that the Patent Office considered a particular prior art, the presumption of validity is mitigated.

17. Patents 🔑51(1)

The label "prior art" cannot be ascribed to a private intracorporate communication.

18. Patents 🔑66(1.2)

Imputing similarity of features to a prior art patent when the patent disclosure teaches otherwise would be inappropriate.

19. Patents 🔑66(1.2)

Court of Appeals cannot measure the anticipatory effect of a patent by speculating as to what might have been gleaned from it; the Court must remain within the four corners of the patent's disclosures.

20. Patents 🔑18

In contrast to the defense of anticipation, which speaks only to the novelty of an invention, the defense of obviousness raises the question of inventiveness. 35 U.S.C.A. § 103.

21. Patents 🔑18

While the ultimate question of patent validity is one of law, the analytical method to be utilized by courts confronted with the question of obviousness includes basic factual inquiries into the scope and content of the prior art, the differences between prior art and the claims at issue, and the level of ordinary skill in the pertinent art.

22. Patents 🔑18

Because of the novelty–inventiveness dichotomy, prior art may result in an invention being obvious even though not anticipated.

23. Patents 🔑36.1(1)

Contemporaneous failures of those who are experts in the art tends to indicate than an invention is not obvious. 35 U.S.C.A. § 103.

24. Patents 🔑18

Creative process existing prior to issuance of plaintiff's patent No. 3,375,800 for a seismic cable depth–controlling paravane was in an embryonic stage, and it would be manifestly unjust to characterize said patent as anything other than innovatively different and not readily obvious to a person of ordinary skill in the field of marine seismology. 35 U.S.C.A. § 103.

25. Patents 🔑237

It is precisely because minor modifications are sufficient to avoid literal infringement that the protection afforded patentees by the doctrine of equivalents must not be emasculated by too quick a stroke of the judicial pen.

26. Patents 🔑237

Doctrine of equivalents plays an important role in protecting patent claims from the enterprising minor deviations of invention "pirates."

27. Patents 🔑314(5)

A finding of equivalence is a determination of fact.

28. Patents 🔑237

Defendant's accused device infringed the range of equivalents of plaintiff's patent for a seismic cable depth–controlling paravane.

29. Patents 🔑168(2)

Doctrine of file wrapper estoppel, which prevents a patentee from reclaiming through the doctrine of equivalents that which was voluntarily surrendered by the narrowing of the language of patent claims in order to avoid prior art cited by the Patent Office, was inapplicable to plaintiff's patent for a seismic cable depth–controlling paravane; the range of equivalents had not been so limited as to preclude a finding of infringement by defendant's patent.

30. Patents 🔑312(1)

A patent applicant is not presumed to have narrowed his claim more than was necessary to satisfy the Patent Office's challenge.

C. Frederick Levdig, John W. Kozak, H. Michael Hartmann, Chicago, Ill., Frank B. Pugsley, G. Bryon Jamison, Houston, Tex., for plaintiff–appellant, cross–appellee.

Pravel, Wilson & Gambrell, Albert B. Kimball, Jr., B. R. Pravel, Houston, Tex., for defendants-appellees, cross–appellants.

Appeals from the United States District Court for the Southern District of Texas.

Before RUBIN and POLITZ, Circuit Judges, and SMITH *, United States District Judge.

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* District Judge of the Northern District of Mississippi, sitting by designation.

POLITZ, Circuit Judge:

Continental Oil Company (Conoco) appeals the determination by the trial court that its patent for a seismic cable depth-controlling paravane is not infringed by a device patented by Jimmy R. Cole. Cole cross-appeals, challenging the validity of Conoco's patent. We disagree with the trial judge and conclude that Cole's device infringes, being equivalent in function and operation to Conoco's paravane. We also conclude that Conoco's patent is valid. We therefore reverse the decision of the trial judge, render judgment in favor of Conoco and remand for further proceedings.

[1-3] The issues posited to us can be resolved by applying well-established principles which have been stated and re-stated and, in the main, need only be capsulated. The sine qua non of appellate review of patent litigation is the notion that validity and interpretation are legal questions based upon factual inquiries. When confronted with pure questions of law, we are free to examine the district judge's answers and correct any error or oversight. In contrast, factual questions resolved by the trial court warrant deference and reversal is mandated only if the findings are clearly erroneous. Fed.R.Civ.P. 52(a). Although infringement normally is a fact question, legal questions of construction can become so intertwined that the clearly erroneous standard of review applicable to a pure fact finding must yield. The appeal we now decide falls into this latter category.

[4, 5] One form of infringement occurs when an accused device incorporates a teaching literally read. An infringement also occurs when a device appropriates a prior invention by incorporating its innovative concept and, albeit with some modification and change, performs substantially the same function in substantially the same way to achieve substantially the same result. The "doctrine of equivalents" shields the inventor from such abuse.

[6-8] The determination of equivalency involves an examination of the scope of prior art, the essence or "heart" of the invention disclosed and the step forward the invention offers. A pioneer or generic patent which opens a new path is entitled to broader protection than a patent which merely improves upon that which is already known. The ambit of equivalency is also limited by the claims as made, amended or surrendered in the process which make up the "file wrapper" and grounds the defense of "file wrapper estoppel."

These principles were essentially noted by us in our recent decision in *Weidman Metal Masters v. Glass Master Corp.*, 623 F.2d 1024 (5th Cir. 1980), and cases cited therein, particularly *Studiengesellschaft Kohle v. Eastman Kodak Co.*, 616 F.2d 1315 (5th Cir. 1980).

[9] In the case *sub judice* we are not favored with "findings ... sufficiently detailed to give us a clear understanding of the analytical process by which ultimate findings were reached and to assure us that the trial court took care in ascertaining the facts." *Golf City, Inc. v. Wilson Sporting Goods, Co., Inc.*, 555 F.2d 426, 433 (5th Cir. 1977). Instead, the trial court's findings are in the main conclusory. In this situation we routinely would remand for more specific findings. However, "[t]his failure is merely a hindrance and not a fatal error." *Whitley v. Road Corp.*, 624 F.2d 698, 700 (5th Cir. 1980). "Where the evidence is such that without weighing the credibility of the witnesses there can be but one reasonable conclusion as to the result, the case can be taken from the factfinding body." *Waldon, Inc. v. Alexander Manufacturing Company*, 423 F.2d 91, 93 n.3 (5th Cir. 1970).

The record is replete with evidence fully establishing the pertinent facts as they relate to infringement and validity. In the interest of judicial and other economies we are constrained to make the required factual collation to which we apply the legal principles resolving this dispute.

[10] The questions before the court concern the validity of Conoco's patent, U. S. Patent 3,375,800 (the '800 patent), and

whether it is infringed by Cole's patent, U. S. Patent 3,931,608 (the '608 patent).[1]

A. *Factual Background*

The invention which has bred this litigation was birthed by the need to efficiently and economically locate structures beneath the ocean floor which are likely to contain oil and gas deposits. Seismic survey crews first conducted their tests on land, and later went offshore as the technology in this field advanced.

Whether on land or at sea, seismic surveys are made by electronically transmitting sound waves down into the subsurface where, on the rebound, the signals are received and recorded on surveyor's charts. The study of these charts by persons with knowledge of subterranean geological formations leads to educated adumbrations as to whether the area contains a structure which may accommodate commercial quantities of oil and gas.

In marine seismic surveying the return sound waves are received in the water above the ocean floor by instruments called hydrophones which are spaced along and are integral parts of a cable towed behind a survey boat. Maintaining these hydrophones at a constant depth while minimizing unwanted "noise" is essential to the accuracy of seismic readings. Prior to Conoco's paravane invention, depth was controlled primarily by attaching floats and weights to a neutrally bouyant cable. This equipment tended to create substantial noise which interfered with and distorted the return signals, markedly reducing the accuracy and usefulness of information generated. A further drawback inherent in displaying the cable by means of floats and weights, in order to maintain a constant depth, was the limitation in the area a crew could survey in a routine day. In sum, not only was the pre–paravane process slow, arduous and uncertain, but costly delays were frequently encountered.

The '800 patent claims a device co-invented by Cole while he worked for Conoco as an electrical engineer. The patent discloses a depth–sensing paravane (also called cable levelers, cable controllers or "birds") which can be attached at spaced intervals to a marine seismic cable. The paravanes take the cable to a pre–set depth and maintain that depth while the cable is under tow. The evidence is uncontroverted that the paravanes of the '800 patent were a significant step forward in the technology of marine seismography. The device not only affords precise depth control with a minimum of noise, but also greatly increases speed in use. One witness with forty years of experience in seismic surveying testified that before using the Conoco paravanes, his surveying capacity was limited to 500 miles during a two month period. With the use of Conoco's paravanes, however, this range increased to 2,000 miles. Several witnesses emphasized the improvement in the accuracy of the seismic readings resulting from the reduction in the noise previously associated with controlling the cable depth. Finally, acceptance within the seismic survey industry also reflects the value of this invention. Within a short time after the paravanes became available a majority of the marine crews throughout the world were using them, including the crews of some of the largest companies.

B. *The Patents in Suit*

In resolving the issue of the validity of the Conoco patent, and in conjunction with our review of the infringement issue, we must examine the physical function and operation of three paravanes and certain accompanying patent claims. The first, the '800 patent, was co-invented by Cole and Paul L. Buller while Cole was, as noted, employed by Conoco. The second, the '608 patent, was patented by Cole four years after he left his employment with Conoco and went into business for himself. The third paravane, relevant only insofar as it represents the state of the prior art against which the validity of the '800 patent is to be tested, is U. S. Patent 3,372,666 (the '666 patent or Baker patent) owned by Texas Instruments.

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[1] We adhere to the view that determination of the validity of a patent should not be sidestepped for convenience by addressing only the infringement issue when the question of validity is raised. *See Sinclair Co. v. Interchemical Corp.*, 325 U.S. 327, 330, 65 S.Ct. 1143, 1145, 89 L.Ed. 1644 (1945) ("of the two questions [concerning validity or infringement], validity has the greater public importance"); *Beckman Instruments, Inc. v. Chemtronics, Inc.*, 428 F.2d 555, 558 n.4 (5th Cir.), *cert. denied*, 400 U.S. 956, 91 S.Ct. 353, 27 L.Ed.2d 264 (1970) ("when a challenge is made to the validity of a patent in an infringement suit, that issue should ordinarily be taken up first and infringement considered only if validity is decided favorably to the patentee").

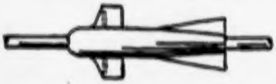
1. Conoco Patent

The Conoco patent teaches an axial bore traversing the center of the embodiment of the invention through which the seismic cable passes. In other words, the paravene is placed concentrically around the cable. Because of the cable's length, usually one to two miles, it inevitably twists and turns while under tow. To prevent this movement from spinning or flipping the paravanes, each paravane is affixed by a pair of bearings, fore and aft, which permits the cable to rotate freely. By connecting the inner race of one or both of the bearings to the cable, the paravane is prevented from moving lengthwise along the cable and thus maintains its proper spacing.

In the commercially preferred manifestation of Conoco's invention, the cable-receiving bore penetrates through the center of the paravane housing. The patent, however, also discloses alternative designs in which the bearings which form the bore for receiving the seismic cable are offset from, but parallel to, the length of the main paravane housing. The depth-sensing and regulating mechanism, several variations of which are embraced by the patent, can be interchanged in the various paravane designs.

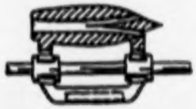
U.S. Patent 3,375,800

Conoco's commercially preferred design with paravane housing placed concentrically around cable.



U.S. Patent 3,375,800

Conoco's alternative design with paravane offset from but parallel to cable.

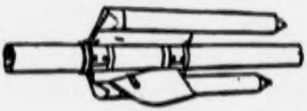


2. Cole Patent

In 1972 Cole departed his employment with Conoco. He made several efforts at developing a paravane and in 1976 secured the '608 patent which is the basis of this infringement suit. After wading through a maze of insensate semantics we are convinced that the Conoco and Cole paravanes are conceptually and functionally identical. We are notably unimpressed by the testimony of the expert offered by Cole purporting to meaningfully distinguish the two devices. Both are equipped with an internal depth-sensing mechanism connected to a pair of vanes which operates to seek and maintain a predetermined depth. Both paravanes are structured and operate to counteract upward, downward and rotational forces. Both permit the cable to rotate freely. Lastly, both limit the noise produced in accomplishing depth control and constancy.

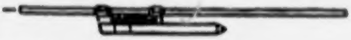
[11] In patent validity and infringement litigation the task of discerning reticent dissimilarities is as imperative as noting the more visible similarities. In this vein we note that Cole's model differs from Conoco's commercial version in the following respects. First, the accused paravane is offset from the cable. Second, because the

paravane is offset from the cable, the rotational capability is achieved by mounting the paravane on the cable through bearings located in collars which permit free movement of the cable. Third, approximately one out of every four paravanes sold by Cole comes equipped with an upper flotation device.



U.S. Patent 3,931,608

Cole's paravane with optional upper flotation housing.



U.S. Patent 3,931,608

Cole's paravane without upper flotation housing.

C. *Patent Validity*

[12] Relying on the Baker Patent[2] issued in 1968, and on a 1965 working model of Baker's device, Cole maintains that: (1) Conoco's paravane was anticipated by the prior art, and (2) the '800 patent claims were obvious to one ordinarily skilled in the art.[3]

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[2] Cole submits for consideration three additional patents as evidence of the prior art: Dorsey, U. S. Patent 1,625,245; Hammond, U. S. Patent 2,401,929; and Paslay, U. S. Patent 2,465,696. We find that the extent of dissimilarity between each of these patents and the '800 patent far exceeds that between the Baker and Conoco inventions. As our further discussion reflects, the degree of dissimilarity is sufficient to defeat any resort to prior art in challenging the validity of the '800 patent.

Although it may be true, as Cole contends, that a certain degree of visual similarity exists between the three earlier patents and the Conoco patent, this alone does not support a finding of similarity in structure and function. Important dissimilarities are also readily apparent—dissimilarities we find instructive in determining the prior art. The Paslay patent, for example, teaches the affixation of a drogue-type paravane at the end of the seismic cable, with an optional paravane which may be attached to the cable directly behind the boat by means of a secondary cable. Neither paravane is situated concentrically around nor rotatably attached to the seismic cable. The Dorsey drogue-type paravane similarly can only be rigidly attached to the end of a seismic cable and does not contain a bore through which the cable passes. Finally, the Hammond patent, which discloses the use of multiple apparatuses at staggered intervals along parallel cables at two different depths, refers us back to the Dorsey patent. The cables apparently are depth-controlled by a paravane located at the front of each cable. Given the above basic difference between the Conoco and the three earlier patented devices, we find it unnecessary to further explore this avenue of purported prior art.

The earlier patents raised by Cole accentuate the extent of the difficulty encountered in solving the problem of efficiently and economically gathering accurate seismic readings in water. This evidence tends to enhance the novelty of the '800 patent. *See Reynolds v. Whitin Mach. Works,* 167 F.2d 78 (4th Cir.), *cert. denied,* 334 U.S. 844, 68 S.Ct. 1513, 92 L.Ed. 1788 (1948) (21 patents cited by defendant to prove lack of novelty of plaintiffs' invention). The '800 patent solved the problem the others failed to solve.

[3] Adopting both grounds advanced by Cole, the district court intimated a finding of invalidity in the following statement:

> If plaintiff's patent claims ... were construed as plaintiff contends ... the claims ... of the "800" patent in suit [would read] squarely on the Baker patent disclosure and also the prior Baker working model in evidence.

Not only is this statement unsupported by the evidence, it is inconsistent with the court's later observation that the finding of noninfringement "precludes the necessity of passing upon the issue of invalidity of Conoco's patent." The Final Judgment signed by the district judge, which Conoco states was prepared by counsel for Cole and signed over its objection, contained the reference to the invalidity of the '800 patent, an issue that apparently had not been decided.

1. Anticipation and the Prior Art

In 1965 Buford M. Baker, an employee of Texas Instruments, conceived a seismic cable depth-controlling apparatus (the "Baker working model"). An in-house sketch prepared for the patent department of Texas Instruments contained the instruction: "Streamer [seismic cable] is free to rotate at attaching point." The invention ultimately issued as the '666 patent three years later, predating the '900 patent by less than three weeks. The rotatability feature was not part of the disclosure of the Baker patent application. Instead, the '666 patent teaches that the device is "clamped" to the cable.

[13] The defense of anticipation derives principally from 35 U.S.C. § 102(a) which provides:

> A person shall be entitled to a patent unless—(a) the invention was known or used by others in this country, or patented or described in a printed publication in this or a foreign country, before the invention thereof by the applicant ....

It has been held repeatedly that not only is the defense of anticipation strictly a technical one, but that unless all of the same elements or their equivalents are found in substantially the same situation where they do substantially the same work in the same way, there is no anticipation.[4] Applying this definition to the state of the prior art in the instant case, we reject Cole's contention that the '900 patent was anticipated by either the Baker working model or the subsequent '666 patent.

[14-16] Our conclusion that the Conoco device was a breakthrough in the seismic industry and was not precursored by the Baker working model and its progeny rests on several bases. First, a presumption of validity arises from the issuance of a patent, *see Beckman Instruments, Inc. v. Chemtronics, Inc.*, 428 F.2d 555 (5th Cir.), cert. *denied*, 400 U.S. 956, 91 S.Ct. 353, 27 L.Ed.2d 264 (1970). This is especially so in a case such as that before us where the same patent examiners simultaneously reviewed the allegedly contending applications, *see McCutchen v. Singer Company*, 386 F.2d 82 (5th Cir. 1967). *See also* 35 U.S.C. § 102(e), codifying the rule enunciated in *Milburn Co. v. Davis etc. Co.*, 270 U.S. 390, 46 S.Ct. 324, 70 L.Ed. 651 (1926) (date patent application is filed is used for the purpose of anticipating a subsequent invention). Although *McCutchen*, 386 F.2d at 85, supports the presumption of validity once a patent issues without the suggestion of interference by the Patent Office, *Beckman*, 428 F.2d at 561, goes one step further and reasons that if there is no evidence that the Patent Office considered a particular prior art, the presumption of validity is mitigated. *See also Parker v. Motorola, Inc.*, 524 F.2d 518 (5th Cir. 1975), *cert. denied*, 425 U.S. 975, 96 S.Ct. 2175, 48 L.Ed.2d 799 (1976); *Gaddis v. Calgon Corporation*, 506 F.2d 880 (5th Cir. 1975). Despite the simultaneous review by the same examiners, we shall, for present purposes, presume that the Patent Office did not consider the Baker patent before issuing the Conoco patent and subject both patents to an examination in that light.

[17] Of particular importance from Cole's viewpoint is the reference to rotatability in the Baker working model. This critical revelation soon vanishes, however, in light of evidence indicating the intended or inadvertent suppression of the invention. Baker's description of the experimental model tested during the summer of 1965 appeared in a "Patent Disclosure Instruction and Cover Sheet" which he privately submitted to the patent department of Texas Instruments. It did not become public

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[4] *See Steelcase, Inc. v. Delwood Furniture Co., Inc.*, 578 F.2d 74, 78 (5th Cir.), *cert. denied*, 440 U.S. 980, 99 S.Ct. 1503, 59 L.Ed.2d 773 (1978) ("The test for anticipation ... requires a showing of actual identity in the prior art ...."); *Yoder Bros., Inc. v. California-Florida Plant Corp.*, 537 F.2d 1347, 1377 (5th Cir. 1976), *cert. denied*, 429 U.S. 1094, 97 S.Ct. 1108, 51 L.Ed.2d 540 (1977); *Ziegler v. Phillips Petroleum Company*, 483 F.2d 858, 868 (5th Cir.), *cert. denied*, 414 U.S. 1079, 94 S.Ct. 597, 38 L.Ed.2d 485 (1973); *Harrington Manufacturing Co., Inc. v. White*, 475 F.2d 788 (5th Cir.), *cert. denied*, 414 U.S. 1040, 94 S.Ct. 542, 38 L.Ed.2d 331 (1973); *Van Gorp Mfg., Inc. v. Townley Industrial Plastics, Inc.*, 464 F.2d 16 (5th Cir. 1972).

information. We cannot ascribe the label "prior art" to a private intracorporate communication of this nature. *See Stamicarbon, N. V. v. Escambia Chemical Corporation*, 300 F.Supp. 1209, 1215 (N.D.Fla.1969), *aff'd as modified*, 430 F.2d 920 (5th Cir.), *cert. denied*, 400 U.S. 944, 91 S.Ct. 245, 27 L.Ed.2d 248 (1970) ("secret uses which are not publicly known or disclosed do not constitute 'prior art' under the provisions of 35 U.S.C. §§ 102 and 103").

[18, 19] We similarly reject Baker's '666 patent as prior art. Accepting *per arguendo* the contention that the rotatability feature noted in the private sketch of Baker's working model is analogous to that component of the '800 patent, imputing that similarity to the '666 patent when the patent disclosure teaches otherwise would be inappropriate. The fact that the '666 patent described the point where the paravane is attached to the seismic cable as a "clamp," rather than a rotatable apparatus, cannot be dismissed in the words of Cole's witness as "just an oversight by the patent attorney." We cannot measure the anticipatory effect of a patent by speculating as to what might have been gleaned from it. We must remain within the four corners of the patent's disclosures. *See, e. g., McCullough Tool Company v. Well Surveys, Inc.*, 343 F.2d 381 (10th Cir. 1965), *cert. denied*, 383 U.S. 933, 86 S.Ct. 1061, 15 L.Ed.2d 851 (1966); *Illinois Tool Works, Inc. v. Continental Can Company*, 273 F.Supp. 94 (N.D. Ill.1967), *aff'd*, 397 F.2d 517 (7th Cir. 1968).

We further note the overwhelming evidence adduced at trial reflecting not only the substandard operational capability of the Baker invention, but also the rudimentary level of technical development achieved. During experimental runs the Baker device had a tendency to oscillate, occasionally "porpoising" out of the water. In the words of Baker's supervisor, "innovative engineering" was needed to reduce the Baker concept to practice and develop it into an operationally useful device. *See United States v. Adams*, 383 U.S. 39, 50, 86 S.Ct. 708, 713, 15 L.Ed.2d 572 (1966) ("An inoperable invention or one which fails to achieve its intended result does not negative novelty."). Accordingly, we find that the prior art does not invalidate the '800 patent.

2. Obviousness

[20, 21] Cole next alleges that the '800 patent claims were obvious, thereby rendering the patent invalid under 35 U.S.C. § 103. In contrast to the defense of anticipation, which speaks only to the novelty of an invention, the defense of obviousness raises the question of inventiveness. Section 103 provides:

> A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Thus, while the ultimate question of patent validity is one of law, the analytical method to be utilized by courts confronted with the question of obviousness includes basic factual inquiries into the scope and content of the prior art, the differences between prior art and the claims at issue, and the level of ordinary skill in the pertinent art. *See Graham v. John Deere Co.*, 383 U.S. 1, 86 S.Ct. 684, 15 L.Ed.2d 545 (1966); *John Zink Co. v. National Airoil Burner Co.*, 613 F.2d 547 (5th Cir. 1980).

[22] A substantial portion of our prior discussion concerning anticipation by the prior art is pertinent in resolving the question of obviousness. Because of the novelty–inventiveness dichotomy, however, prior art may result in an invention being obvious even though not anticipated. *See e. g., Harvey v. Levine*, 322 F.2d 481 (6th Cir. 1963); *Amphenol Corporation v. General Time Corporation*, 397 F.2d 431 (7th Cir. 1968).

[23] The linchpin is not whether the individual components of the '800 patent were obvious at the time of the invention, but whether the aggregation produced a new or different result or achieved a synergistic effect. *See Ingersoll–Rand Company v. Brunner & Lay, Inc.*, 474 F.2d 491, 496 (5th Cir.), *cert. denied*, 414 U.S. 865, 94 S.Ct. 125, 38 L.Ed.2d 117 (1973). *See also Adams v. United States*, 330 F.2d 622, 625, 165 Ct.Cl. 576 (1964), *aff'd*, 383 U.S. 39, 86 S.Ct. 708, 15 L.Ed.2d 572 (1966) ("While the use of any of the individual components ... may have been obvious at the time of the invention, the invention as a whole was not obvious ...."). In addition to the several patents Cole raised which we have noted above as non-dispositive, the remaining semblance of prior art against which the '800 patent must be compared is the Baker patent. As previously recognized, the Baker patent does not teach utilization of a rotatable seismic cable. It is also evident that Baker and other Texas Instrument employees involved in the invention possessed not only ordinary, but most likely extraordinary skill in the art. Yet by the time Conoco obtained the '800 patent in 1968, Baker and his co-workers had spent over three years trying unsuccessfully to produce a functional paravane.[5]

[24] Having compared the Conoco paravane with the prior art, we are convinced that the creative process existing prior to issuance of the '800 patent was in an embryonic stage. It would be manifestly unjust to characterize the '800 patent as anything other than innovatively different and not readily obvious to a person of ordinary skill in the field of marine seismology. We find the '800 patent valid and proceed to assay the district judge's holding that the '606 patent did not infringe.

D. *Infringement*

The final issue is whether Cole's '606 patent infringes Conoco's '800 patent. The allegation stems from five claims of the '800 patent, numbers 1, 2, 4, 22 and 25, the most controversial and inclusive of which reads in part:

> 1. A paravane ... comprising: a housing having a bore means along its length thereof ....

The parties to this case as well as the district judge put much emphasis on the interpretation to be accorded this language. We do not find a *strictissimi* interpretation necessary given the liberal construction warranted by the doctrine of equivalents.

[25, 26] We accept the finding of the district court that sufficient differences exist between the Conoco and Cole inventions to avoid literal infringement. We underscore, however, that it is precisely because "minor modifications are ... sufficient to avoid literal infringement," *Weidman Metal Masters v. Glass Master Corp.*, 623 F.2d 1024, 1026 (5th Cir. 1980), that the protection afforded patentees by the doctrine of equivalents must not be emasculated by too quick a stroke of the judicial pen.[6]

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[5] The contemporaneous failures of those who are experts in the art tend to indicate that an invention is not obvious. *See e. g., Illinois Tool Works, Inc. v. Continental Can Company*, 397 F.2d 517 (7th Cir. 1968). The failures experienced by the Baker group were not mere construction infirmities requiring only slight modifications, but were design defects requiring innovative engineering.

[6] Recognizing the important role played by the doctrine of equivalents in protecting patent claims from the enterprising minor deviations of invention "pirates," the Supreme Court in *Graver Mfg. Co. v. Linde Co.*, 339 U.S. 605, 607, 70 S.Ct. 854, 855–56, 94 L.Ed. 1097 (1950), stated:

> In determining whether an accused device or composition infringes a valid patent, resort must be had in the first instance to the words of the claim. If accused matter falls clearly within the claim, infringement is made out and that is the end of it.
>
> But courts have also recognized that to permit imitation of a patented invention which does not copy every literal detail would be to convert the protection of the patent grant into a hollow and useless thing. Such a limitation would leave room for–indeed encourage–the unscrupulous copyist to make unimportant and insubstantial changes and substitutions in the patent which, though adding nothing, would be enough to take the copied matter outside the claim, and hence outside the reach of law. One who seeks to pirate an invention, like one who seeks to pirate a copyrighted book or play, may be expected to introduce minor variations to

1. Doctrine of Equivalents

[27, 28] We are cognizant that a finding of equivalence is a determination of fact. *Ziegler v. Phillips Petroleum Company*, 483 F.2d 858 (5th Cir.), *cert. denied*, 414 U.S. 1079, 94 S.Ct. 597, 38 L.Ed.2d 485 (1973). In this case, however, the breadth of the doctrine of equivalents is a question of law because it concerns the construction of the '800 patent. *See Coupe v. Royer*, 155 U.S. 565, 15 S.Ct. 199, 39 L.Ed. 263 (1895). Our perception of the doctrine of equivalents is best expressed by this Supreme Court teaching:

> What constitutes equivalency must be determined against the context of the patent, the prior art, and the particular circumstances of the case. Equivalence, in the patent law, is not the prisoner of a formula and is not an absolute to be considered in a vacuum. It does not require complete identity for every purpose and in every respect. In determining equivalents, things equal to the same thing may not be equal to each other and, by the same token, things for most purposes different may sometimes be equivalents. Consideration must be given to the purpose for which an ingredient is used in a patent, the qualities it has when combined with the other ingredients, and the function which it is intended to perform.

Graver Mfg. Co. v. Linde Co., 339 U.S. 605, 609, 70 S.Ct. 854, 856, 94 L.Ed. 1097 (1950). Once the framework for determining equivalency had been erected, it becomes readily apparent that the Cole device has infringed the range of equivalents of the '800 patent.

2. File Wrapper Estoppel

[29] Finally, we address the applicability of the doctrine of file wrapper estoppel. This doctrine prevents a patentee from reclaiming through the doctrine of equivalents that which was voluntarily surrendered by the narrowing of the language of the patent claims in order to avoid prior art cited by the Patent Office. The district judge concluded the doctrine applies. We disagree, being of the opinion that the range of equivalents has not been so limited as to preclude a finding of infringement by the Cole patent.

[30] The original application for the '800 patent was filed in December 1966 and embraced only the commercially preferred design with the paravane placed concentrically around the seismic cable. In April 1967, a continuation-in-part application was filed which included other manifestations of the invention. The district judge concluded that the original claims were broad enough to cover the accused device, but that the continuation-in-part constituted a disclaimer which now estops Conoco from asserting that which it previously surrendered. We reject the district judge's conclusion for three reasons. First, in *Hunt Tool Company v. Lawrence*, 242 F.2d 347 (5th Cir.), *cert. denied*, 354 U.S. 910, 77 S.Ct. 1296, 1 L.Ed.2d 1428 (1957), we noted that a patent applicant is not presumed to have narrowed his claim more than was necessary to satisfy the Patent Office's challenge. Second, in the case before us, there is no evidence in the file history that the Conoco application was amended because of the Patent Office's rejection based on prior art. Third, because the '800 invention solved a sophisticated and stubborn problem in the field of marine seismology, which had long remained unresolved despite vast research and development efforts conducted over a number of years, a broader degree of protection is to be afforded under the doctrine of equivalents than that ascribed by the district judge.[7]

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conceal and shelter the piracy. Outright and forthright duplication is a dull and very rare type of infringement. To prohibit no other would place the inventor at the mercy of verbalism and would be subordinating substance to form. It would deprive him of the benefit of his invention and would foster concealment rather than disclosure of inventions, which is one of the primary purposes of the patent system.

[7] We do not go so far as to classify the '800 patent as a pioneer, *i. e.*, "a patent covering a function never before performed, a wholly novel device, or one of such novelty and importance as to mark a distinct step in the progress of the art," but neither do we consider the

Cole contends that on the basis of file wrapper estoppel, his '608 patent does not infringe the following language of Claim No. 1 of the '800 patent: "a housing having a bore means along its length thereof." He emphasizes that the *housing* structure of the '608 paravane does not *have* a bore means (that portion of the paravane that receives and allows rotation of the cable) along its length. His argument rests largely on the trial judge's finding that the collars securing the main body of the paravane to the cable do not constitute part of the housing. Were we to agree that the doctrine of equivalents is to be narrowly applied it would be necessary to carefully analyse these terms. Because we hold that broad protection is to be accorded the '800 patent claims we find it unnecessary to engage in that exercise.

The '800 and '608 patents involve more than a similarity in result. The evidence "establish[es] substantial identity of means, operation and result." *Foster Cathead Company v. Hasha*, 382 F.2d 761, 765 (5th Cir. 1967), *cert. denied*, 390 U.S. 906, 88 S.Ct. 819, 19 L.Ed.2d 872 (1968), *quoting* C. Pigott, Equivalents in Reverse, 48 Journal of the Patent Office Society 291–92 (1966). The '608 patent infringes the '800 patent.

The decision of the district court is REVERSED. We hold that Conoco's patent, U. S. Patent 3,375,800 is valid and that it is infringed by Cole's patent, U. S. Patent 3,581,608. The case is REMANDED for further proceedings consistent with this opinion.

REVERSED, RENDERED and REMANDED.

E. A. GREGORY and Vesma Jo Gregory, Plaintiffs–Appellants,

v.

Dennis M. MITCHELL, Individually and in his capacity as Alabama State Superintendent of Banks and as Chairman and Ex Officio a Member of the Alabama State Banking Board, et al., Defendants–Appellees.

No. 79-3129.

United States Court of Appeals,
Fifth Circuit.

Jan. 12, 1981.

Rehearing Denied Feb. 11, 1981.

Stockholders of state chartered bank brought action against, among others, Alabama Superintendent of Banks, the Federal Deposit Insurance Corporation and the United States. The United States District Court for the Middle District of Alabama, Frank M. Johnson, Jr., J., granted motions to dismiss as filed by FDIC and the United States and rendered summary judgment for defendants, and plaintiffs appealed. The Court of Appeals, Politz, Circuit Judge, held that: (1) stockholders were not the proper parties to press civil rights claim on behalf of the bank and the bank, which had been taken over by state authorities, also was not a proper party plaintiff; (2) refusal to exercise pendent jurisdiction was proper; (3) denial, as untimely, of motion to amend to assert a shareholder derivative action thereby invoking diversity jurisdiction, was proper; (4) where there was no formal denial of claim filed with FDIC, institution of action prior to expiration of six–month period of administrative review deprived the district court of jurisdiction and court could not stay or hold the action in abeyance until the six–month period accrued; and (5) the "sue and be sued" clause did not confer jurisdiction over the FDIC for purpose of monetary relief for tort claims.

Affirmed.

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invention to be "a mere improvement or perfection of what had gone before." *Westinghouse v. Boyden Power Brake Co.*, 170 U.S. 537, 561–62, 18 S.Ct. 707, 718, 42 L.Ed. 1136 (1898). The '800 patent falls someplace in between, as does the measure of protection to be afforded to it.

APPENDIX B

B-1

CLERK, U.S. DISTRICT COURT
SOUTHERN DISTRICT OF TEXAS
FILED
MAR 6 1979
V. BAILEY THOMAS, CLERK
BY DEPUTY: Sam Ventura

IN THE UNITED STATES DISTRICT COURT
FOR THE SOUTHERN DISTRICT OF TEXAS
HOUSTON DIVISION

CONTINENTAL OIL COMPANY I
I
VS I CIVIL ACTION NO. H-75-1288
I
JIMMY R. COLE, D/B/A JIM I
R. COLE & ASSOCIATES AND I
COLE DEVELOPMENT COMPANY, I
INC. I

MEMORANDUM

Plaintiff, Continental Oil Company ("Conoco") sues for infringement under the Patent Laws of the United States, Title 35 U.S.C. against Jimmy R. Cole, d/b/a/ Jim R. Cole & Associates ("Cole") and Cole Development Company, Inc. ("Cole Development"). This Court has jurisdiction of the parties and of the subject matter of this action by virtue of U.S.C. §1338 and §2201. Venue is properly laid in this district under Title 28 U.S.C. §1406(b). Defendant Cole alleges that plaintiff's patent is invalid and alternatively that defendant's patent does not infringe.

Defendant, while an employee of plaintiff, obtained Patent No. 3,375,800 (hereinafter the "800" patent). The "800" patent is a device for maintaining an underwater seismic cable at a constant depth while being towed by a ship. After leaving, Conoco, defendant obtained Patent No. 3,931,608 (hereinafter the "608" patent) on an improved underwater cable depth controller, which device is the alleged infringing apparatus. Defendants' manufacture and sell two models of their cable depth controllers, one of which is shown in Fig. 1 of defendants' United States Patent 3,931,608, and the other of which is shown in Fig. 3 of the same patent. The difference between the two models is that the Fig. 3 model includes an additional flotation tube assembly T. The evidence shows that a vast majority of the defendants' cable depth controllers which have been manufactured and sold are of the type shown in Fig. 1 of U. S. Patent 3,931,608, in which the housing H is located to one side of the streamer or cable K.

Plaintiff claims that defendants wilfully infringed five claims of the "800" patent by the manufacture and sale of a seismic depth control apparatus and, further, that defendants induced the purchasers of the accused apparatus to use it in an infringing manner. The claims of the "800" patent on which Conoco asserts infringement read as follows:

> 1. A paravane for a seismic cable adapted to be towed substantially horizontally through water, comprising: a housing having a bore means along its length thereof, said bore means of a size to receive said seismic cable and allow rotation of said seismic cable without rotation of said housing while transmitting upward and downward forces between the housing and the adjacent portions of said cable; bearing means for securing the housing onto said seismic cable against movement of said housing along said cable; and means carried by the housing including at least one vane for maintaining the paravane at a predetermined depth in the water as the paravane is moved through the water by the cable and for counteracting upward, downward and turning forces imposed on the housing, whereby the paravane maintains the adjacent portions of the said seismic cable at said predetermined depth.
>
> 2. A paravane as defined in Claim 1 wherein said last mentioned means includes: ballast carried by the housing below the cable to counteract turning forces imposed on the housing; depth sensing means carried by the housing; and adjustable diving means carried by the housing, engaging the water and connected to the depth sensing means for varying the depth of the paravane in response to the depth sensing means.
>
> 4. A paravane as defined in claim 2 wherein said adjustable diving means comprises: diving plans rotatably secured to the opposite sides of the housing; and means interconnecting the diving planes for uniform adjustment of the diving planes in response to the depth sensing means.

22. Apparatus for maintaining a seismic cable at a predetermined depth as the cable is being towed substantially horizontally through water, comprising: a plurality of paravanes secured in spaced relation along the cable, each of said paravanes comprising: a housing having a bore means along its length thereof, said bore means of a size to receive said seismic cable and allow rotation of said cable without rotation of said housing while transmitting upward and downward forces between said housing and adjacent portions of said cable; bearing means for securing said housing onto said cable against movement of said housing along said cable; and means carried by the housing including at least a vane for maintaining the paravane at a predetermined depth in the water as the paravane is moved through the water by the cable and for counteracting upward, downward and turning forces imposed on the housing, whereby the paravane maintains the adjacent portion of the cable at said predetermined depth.

25. A paravane for an elongated member adapted to be towed substantially horizontally through water, comprising: a housing having a bore means along its length thereof, said bore means of a size to receive said elongated member and allow rotation of said elongated member without rotation of said housing while transmitting upward and downward forces between the housing and the adjacent portions of said elongated member; bearing means for securing the housing onto said elongated member against movement of the housing along said elongated member; and, means carried by the housing including at least a vane for maintaining the paravane is moved through the water by said member and for counteracting upward, downward and turning forces imposed on the housing, whereby the paravane maintains the adjacent portion of said predetermined depth.

Defendants maintain first that the "800" patent is invalid for obviousness. Secondly, as the five claims of the "800" patent in suit cannot be construed to describe either model of cable depth controller that defendants sell, defendants have not infringed the

"800" patent. Thirdly, the file history of the "800" patent and the amendments made to secure the patent create a "file wrapper estoppel" which prevents plaintiff from now contending that these claims cover defendants' device.

Collateral to the issue of non-infringement are several purely legal issues raised by defendant Cole: (1) there exists an implied royalty-free license to manufacture and sell defendants' devices since plaintiff has granted licensed users of cable depth controllers the unrestricted right to have such depth controllers made by others, (2) with respect to acts performed outside the territorial limits of coverage of the United States Patent Laws, there can be no infringement and (3) plaintiff's alleged knowledge of material and relevant prior art and its failure to disclose such art to the Patent Examiner during the prosecution of the patent in suit renders this an exceptional case under 35 U.S.C. 285 entitling defendants to an award of their attorneys fees.

The "800" patent is a combination patent, i.e. it is a patent in which all of the individual elements are old and the asserted novelty resides in the combination of those elements. The patent must be strictly confined to the particular combination claimed. Patents on a simple combination of known mechanical elements, such as the patent in suit, are difficult to obtain and they are not easily infringed. Foster v. Hasha, 382 F.2d 761, 766 (5th Cir. 1967). For plaintiff to sustain a charge of infringement by defendant, defendant's tools must include all elements explicitly recited in the claim. Omission of a single element in such a claim clearly avoids infringement. Deepsouth Packing Co. v. Laitram Corp., 406 U.S. 518 (1972); Marvin Glass v. Sears, 448 F.2d 60, 61 (5th Cir. 1971).

In addition to direct infringement, there can be infringement under the doctrine of equivalents. This doctrine must be applied narrowly to the particular simple combination patent claimed because they are difficult to obtain and should be sustained. Hughes v. Magnolia Petroleum Co., 88 F.2d 817, 33 (5th Cir. 1937); Stewart-Warner Corp. v. Lone Star Gas Co., 195 F.2d 645 (5th Cir. 1952); Sasko v. Southern Resin and Fiberglass Corporation, 248 F.Supp. 797, (S.D. Fla. 1965), aff'd 373 F.2d 866, (5th Cir. 1967).

To establish equivalency for the purpose of showing infringement of the five claims of plaintiff's patent by defendant, plaintiff must prove that defendant's tools are substantially identical with the arrangement defined in the claim as to structure, mode of operation and results attained. Ziegler v. Phillips Petroleum Co., 483 F.2d 858, 868 (5th Cir. 1973); Harrington Manufacturing Co., Inc. v. White, 475 F.2d 788, 796 (5th Cir. 1973), cert. denied, 38 L.Ed.2d 331 (1973); Marvin Glass & Associates v. Sears, Roebuck and Company, 448 F.2d 60, 61 (5th Cir. 1971).

However, before plaintiff may reach the question of equivalency, he must deal with limitations imposed upon his own patent under the doctrine of file wrapper estoppel. An invention is construed not only in the light of its claims, but also with reference to its file wrapper or prosecution history in the Patent Office. Ziegler v. Phillips Petroleum Company, 483 F.2d 858, 870 (5th Cir. 1973). After prosecution of his patent, an applicant is precluded by the doctrine of file wrapper estoppel from thereafter ignoring restrictive terminology added to the patent and attempting by the doctrine of equivalents to interpret the claim as though the limitations were not present. Graham v. John Deere Co., 383 U.S. 1, 33 (1966); Schriber Co. v. Cleveland Trust Co., 311 U.S. 211, 220-1, (1940); Weber Electric Co. v. Freeman Electric Co., 256 U.S. 668, 677 (1920); Smith v. Magic City Kennel Club, 282 U.S. 784, 789 (1930); Ziegler v. Phillips Petroleum Co. 483 F.2d 858, 870 (5th Cir. 1973). The doctrine of file wrapper estoppel applies whether the restriction added subsequent to application to the Patent Office were proposed by the Patent Examiner or the applicant. Dry Hand Mop Co. v. Squeez-egy Mop Co., 17 F.2d 465, 466 (5th Cir. 1927).

The file wrapper of plaintiff's patent in suit reveals that the only claims broad enough to cover defendants' structure were cancelled and replaced by more limited claims. Each of the structural differences between defendants' structure and plaintiff's claims in suit were a result of amendatory language submitted during prosecution of plaintiff's patent in suit in the Patent Office. Accordingly, as a matter of law under the doctrine of file wrapper estoppel, plaintiff cannot now assert that the amendec claims cover what has been eliminated from coverage during prosecution before the Patent Office.

The broadest claim of the "800" patent which is asserted in this litigation is claim 1. The following elements of Claim 1 have not been included in the defendants' model Fig. 1 or defendants' model Fig. 3:

(a) Defendants' device does not have "a housing having a bore means along its length." This is because the dictionary definition of "housing" is "in mechanics, a frame, box, etc. for containing some part." The only "housing" in the defendants' cable depth controllers is the housing H shown in Figs. 1 and 3 of U. S. Patent 3,931,608, but it does not have "a bore means along its length" as required by Claim 1. Therefore, the structure, "a housing having a bore means along its length", cannot be found in defendants' cable depth controllers.

(b) The collars 20 of the defendant's device cannot be considered a "housing" in accordance with the dictionary definition because they are not for "containing some part".

(c) There is no "bearing means for securing the housing onto said seismic cable" in the defendants' cable depth controller because the housing does not have any bearing means in defendants' cable depth controllers.

(d) The vanes P of the defendants' cable depth controller are not carried by the housing H, but instead are mounted on a separate body S which is attached to the housing H and therefore defendants' cable depth controllers do not have the "means carried by the housing including at least one "vane as recited in Claim 1.

Since the other claims have more elements than Claim 1 and since each of the other claims, 2, 4, 22, and 25 have the foregoing elements which are not found in defendants' cable depth controllers, none of the claims, 1, 2, 4, 22 and 25 of the "800" patent in suit are infringed by defendants' cable depth controllers.

Although the model shown in Fig. 3 of defendants' patent 3,931,608 may look more like the plaintiff's cable depth controller of the "800" patent in suit than the Fig. 1 model of U. S. Patent 3,931,608, the evidence is that the flotation device T is only added in a very limited number of cases and could be omitted entirely, but it does not add any additional element which would cause the Fig. 3 model of defendants' cable depth controller to come within the claims 1, 2, 4, 22 and 25 of the "800" patent in suit.

If plaintiff's patent claims 1, 2, 4, 22 and 25 were construed as plaintiff contends so that the collars 20 of defendants' cable depth controllers were considered as the "bore means" of the housing H, such conclusion would necessarily lead to a reading of the claims 1, 2, 4, 22 and 25 of the "800" patent in suit squarely on the Baker patent disclosure and also the prior Baker working model in evidence.

In view of the above factual determination, this Court finds that neither of defendants' devices infringe the "800" patent. Such finding precludes the necessity of passing upon the issue of invalidity of Conoco's patent. The Court further finds that this is not an exceptional case under 35 U.S.C. §285 by virture of misrepresentation to the Patent Office. Therefore, defendant Cole is not entitled to attorney's fees under 35 U.S.C. §285.

Defendants' attorney will draft a judgment in accordance with the memorandum opinion for submission to this Court.

Signed at Houston, Texas, this 8th day of March, 1978.

Robert O'Conor Jr.

ROBERT O'CONOR, JR.
UNITED STATES DISTRICT JUDGE

APPENDIX C

C-1

UNITED STATES COURT OF APPEALS

Fifth Circuit

DENIALS OF REHEARING EN BANC

(Rule 35 Federal Rules of Appellate Procedure; Local Fifth Circuit Rule 12)

Group 1—Denials where no member of the panel nor Judge in regular active service on the Court requested that the Court be polled on rehearing en banc.

Group 2—Denials after a poll requested by a member of the panel or a Circuit Judge in regular active service.

Group 3—Denials on the Court's own motion after a poll requested by a member of the panel or a Circuit Judge in regular active service.

Title	Docket Number	Date of Denial	Citation of Panel Decision
GROUP 1			
Baker v. Metcalfe	80-1636	2/17/81	N.D.Tex., 633 F.2d 1198
Concerned Democrats of Florida v. Reno	80-5482	2/ 9/81	S.D.Fla., 634 F.2d 629
Continental Oil Co. v. Cole	78-1981	2/12/81	S.D.Tex., 634 F.2d 188
Palaez Del-Casal v. Eastern Air Lines, Inc.	79-2953	2/18/81	S.D.Fla., 634 F.2d 295
U. S. v. Chagra	80-1506	2/ 2/81	W.D.Tex., 636 F.2d 311
U. S. v. McCain	79-5577	2/ 6/81	S.D.Fla., 633 F.2d 581

APPENDIX D

D-1

April 2, 1968 J. R. COLE ET AL 3,375,800

SEISMIC CABLE DEPTH CONTROL APPARATUS

Filed April 7, 1967 3 Sheets-Sheet 1

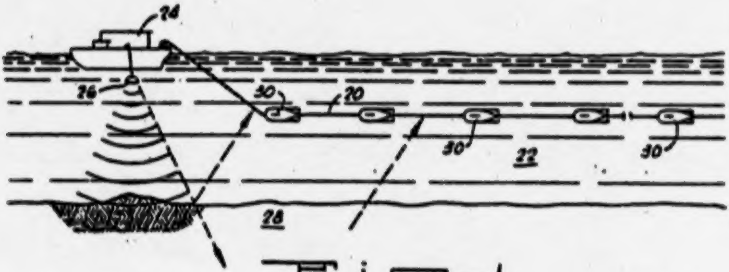

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Fig-1

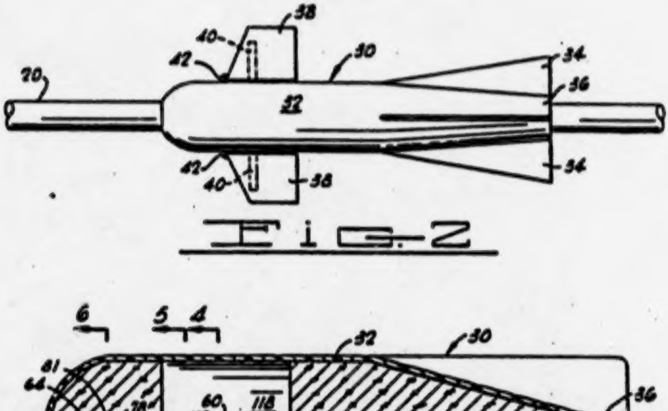

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Fig-2

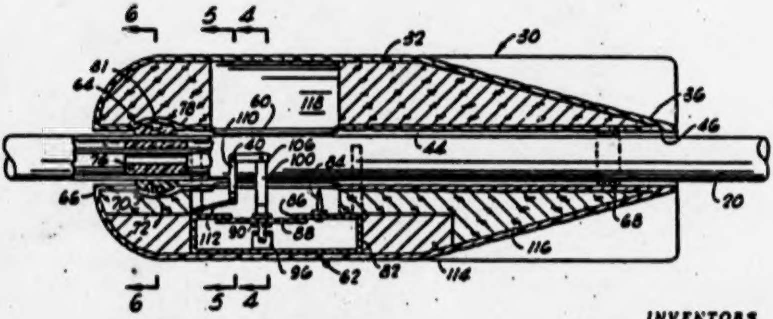

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Fig-3

INVENTORS
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PAUL L. BULLER
BY
William J. Miller
ATTORNEY

D-2

April 2, 1968 J. R. COLE ET AL 3,375,800

SEISMIC CABLE DEPTH CONTROL APPARATUS

Filed April 7, 1967 3 Sheets-Sheet 2

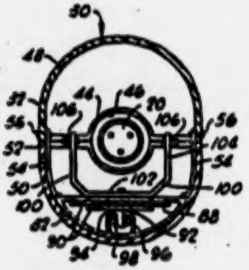
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FIG-4

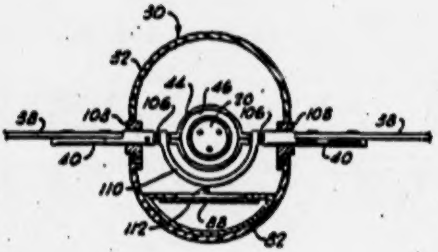
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FIG-5

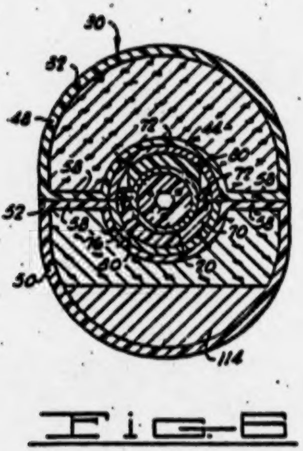
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FIG-6

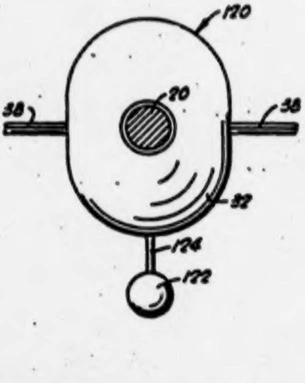
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FIG-7

INVENTORS
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BY

William J. Miller
ATTORNEY

D-3

April 2, 1968 J. R. COLE ET AL **3,375,800**

SEISMIC CABLE DEPTH CONTROL APPARATUS

Filed April 7, 1967 3 Sheets-Sheet 3

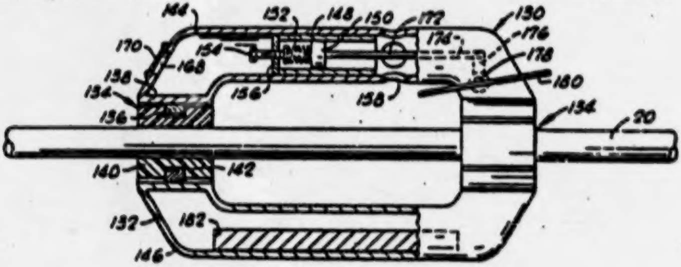
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Fig-8

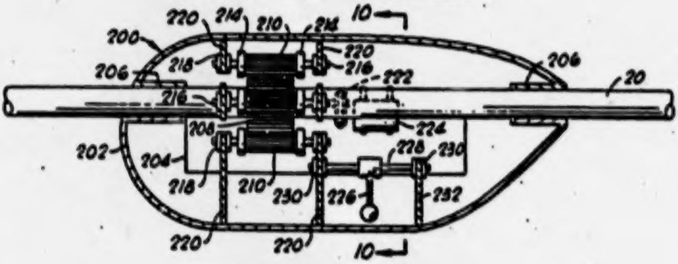
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Fig-9

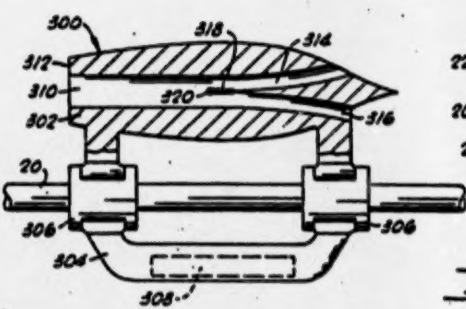
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Fig-11

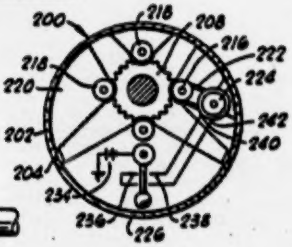
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Fig-10

INVENTORS.
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William J. Miller
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D-4

United States Patent Office

3,375,800
Patented Apr. 2, 1968

3,375,800

SEISMIC CABLE DEPTH CONTROL APPARATUS

Jimmy R. Cole, 1800 N. Ash, and Paul L. Buller, 2305
Drake Lane, both of Ponca City, Okla. 74601

Continuation-in-part of application Ser. No. 604,874,
Dec. 27, 1966. This application Apr. 7, 1967, Ser.
No. 629,276
25 Claims. (Cl. 114—235)

ABSTRACT OF THE DISCLOSURE

A paravane for maintaining a seismic cable being towed through the water at a predetermined depth. The paravane is journaled on the cable and is provided with ballast and stabilizing fins, whereby the paravane will remain oriented vertically and will not spin or turn upon twisting of the cable, as when the direction of movement of the cable is changed by turning of the towing vessel. Diving planes or fins are extended from the opposite sides of the paravane and are controlled by a pressure sensing device mounted in the paravane housing. The pressure sensing device is adjustable such that the diving planes will be turned when the paravane tends to rise or fall in the water above or below a predetermined depth to counteract the forces imposed on the paravane, such that the paravane will maintain the adjacent portion of the cable at the desired predetermined depth.

Cross references to related applications

This is a continuation-in-part of applicants' copending application of the same title filed Dec. 27, 1966, Ser. No. 604,874.

Background of the invention

(1) *Field of the invention.*—This invention relates to an improved paravane for maintaining a seismic cable being towed through water at a predetermined depth.

(2) *Description of the prior art.*—The detectors or hydrophones used in marine seismic operations are normally towed through the water by, and form a part of, a seismic detector cable constructed substantially as disclosed in the United States Patent of Leroy C. Pasley, No. 2,465,699, issued Mar. 29, 1949. The problem with such a cable with which this invention is concerned is the maintenance of the cable at a selected, predetermined depth in the water while the cable is being towed by the surveying vessel. It is not unusual for a marine seismic detector cable to be a mile or even two miles long, and the efficiency of the seismic survey is affected to a large degree by the ability to maintain the various detectors or hydrophones along the length of the cable at the same, predetermined depth in the water. As a practical matter, it has been found impossible to control the specific gravity of the cable sufficiently to maintain the entire cable at a predetermined depth.

Probably the most popular technique heretofore used in an effort to maintain the seismic detector cable at a predetermined depth is by using a plurality of weights tied to the cable at spaced intervals to make the cable negatively buoyant. Floats are then also tied to the cable at spaced intervals, the plan being that the floats would ride on the surface of the water and support the cable at the desired depth. However, the floats are flung about by wave action and surveys simply can not be made in rough water. Also, the specific gravity of the water will frequently vary along the length of the cable and the floats will submerge to varying degrees. Further, it has been found that surveys can be conducted when using this technique normally only during daylight hours, primarily because of the navigational hazard provided by the many floats which are normally used. Finally, it is believed that the noise received by the detectors in the cable is generated to a large degree by the buoys, crashing through waves on the surface of the water, such that an increase in the number of buoys merely increases the noise problem.

Various other techniques have been tried for maintaining a seismic detector cable at a predetermined depth in water, but none have proven satisfactory. For example, a boom is sometimes lowered into the water at the stern of the towing vessel to hold the leading end of the detector cable at the desired depth, but the major portion of the cable will vary in depth as the survey is being conducted. The use of a paravane tied to the trailing end of a detector cable and having automatic depth control capabilities has also been disclosed, but such a paravane will be subject to twisting motions of the detector cable and will not effectively maintain even the trailing end of the cable at the desired depth.

Summary of the invention

In its broader aspects, the present invention contemplates a paravane for a seismic cable adapted to be towed through water which includes an elongated housing rotatably secured on the cable such that the cable may twist without turning or spinning the paravane, and yet vertical forces reacting on the paravane will be transmitted to the cable, and vice versa. The paravane includes means for maintaining the paravane at a predetermined depth in the water as the cable and paravane are moved through the water, whereby the paravane maintains the adjacent portion of the cable at the desired, predetermined depth.

In a more limited and preferred form, the present invention contemplates a paravane housing having an axial bore therethrough receiving the seismic cable, and a bearing structure positioned within the axial bore for journaling the paravane around the cable while preventing lengthwise movement of the paravane along the cable. Depth sensing means are carried in the paravane housing and operate diving planes extending from both sides of the housing to automatically control the depth of the paravane and the adjacent portion of the cable.

This invention also contemplates the combination of a seismic detector cable to be towed through the water and a plurality of paravanes journaled on the cable at spaced intervals for maintaining the entire length of the cable at the desired depth in water.

An object of the invention is to maintain a marine seismic detector cable at a predetermined depth in water as the cable is being towed through the water.

Another object of this invention is to reduce the noise received by the detectors in a marine seismic detector cable.

A further object of this invention is to enable marine seismic surveying operations to be conducted at night as well as at day.

Another object of this invention is to provide a paravane for a marine seismic detector cable which will not be affected by twisting of the cable and which will maintain the adjacent portion of the cable at a predetermined depth in water.

Other objects and advantages of the invention will be evident from the following detailed description when read in conjunction with accompanying drawings which illustrate the invention.

Brief description of the drawings

FIG. 1 is a schematic illustration of a seismic surveying system, including a detector cable being maintained at a predetermined depth in a body of water by a plurality of paravanes constructed in accordance with this invention.

FIG. 2 is a plan view of the preferred paravane structure mounted on said detector cable.

FIG. 3 is a vertical sectional view taken along the longitudinal axis of the preferred paravane structure, with a portion of the detector cable being shown in cross-section.

FIG. 4 is a sectional view taken along lines 4—4 of FIG. 3.

FIG. 5 is a sectional view taken along lines 5—5 of FIG. 3.

FIG. 6 is a sectional view taken along lines 6—6 of FIG. 3.

FIG. 7 is a schematic end view of a slightly modified paravane structure mounted on a seismic detector cable.

FIG. 8 is a side view, partially in section, of a modified paravane structure mounted on a seismic detector cable.

FIG. 9 is a schematic cross-sectional view of another modified paravane structure mounted on a detector cable.

FIG. 10 is a schematic cross-sectional view taken along lines 10—10 of FIG. 9.

FIG. 11 is a side view, partially in section, of still another modified paravane structure mounted on a seismic detector cable.

Description of the preferred embodiment

Referring to the drawings in detail, and particularly FIG. 1, reference character 20 designates a seismic detector cable being towed through a body of water 22 by a survey vessel 24. The survey vessel 24 also tows a seismic energy source 26 through the water 22. The source 26 either continuously or periodically generates sound waves which enter the subsurface 28 below the water 22 as seismic signals and are reflected back upwardly as indicated by the various arrows. The reflected signals are detected by a plurality of detectors or geophones (not shown) carried in the cable 20 and are converted to electrical signals which are in turn conducted through the cable 20 to suitable recording equipment on the survey vessel 24. In accordance with the present invention, the cable 20 is maintained at a predetermined depth in the water 22 by a plurality of paravanes 30 secured in spaced relation along the length of the cable.

As shown in FIG. 2, each preferred form of paravane 30 comprises an elongated housing 32 having vertical and horizontal, fixed, stabilizing fins 34 secured around the rearward end 36 thereof, and having diving planes or vanes 38 supported by shafts 40 on the opposite sides thereof, as will be more fully set forth below. Also, projections or guards 42 are preferably provided on the opposite sides of the housing 32 immediately forward of the inner edges of the diving planes 38 to minimize the possibility of weeds or the like becoming entangled between the diving planes 38 and outer surface of the housing 32.

The housing 32 is substantially hollow and is preferably formed of a light-weight material, such as a material commonly designated as a plastic material. For example, the housing 32 may be molded Teflon or nylon and suitably reinforced if desired. An inner tubular wall 44 (FIG. 3) extends throughout the length of the housing 32 and forms an axial bore 46 extending throughout the length of the housing having a diameter of a size to loosely receive the seismic detector cable 20. Further, and as shown most clearly in FIGS. 4 and 6, the housing 32 is formed in an upper section 48 and a lower section 50 of equal size. That is, the juncture 52 between the upper and lower housing sections 48 and 50 is substantially at the center line of the axial bore 46 extending through the housing, and the exposed surfaces of the housing 32 above and below the center line of the axial bore 46 are of equal area to minimize the tendency of the housing 32 to be turned by cross water currents, as will be set forth more fully below. The upper and lower housing sections 48 and 50 are secured in assembled relation around the cable 20 by a plurality of metal straps 54 suitably secured to the lower housing section 50 and in turn secured at their upper ends to the upper housing section 48 by suitable fasteners 56. The fasteners 56 may be of any desired construction which will enable them to be readily removed for assembly and disassembly of the complete housing 32 around the cable 20. It will also be observed in FIG. 6 that the inner tubular wall 44 of the housing 32 is split at the juncture 52 between the upper and lower housing sections 48 and 50, and the respective halves of the tubular wall 44 are secured to the outer shell of the housing 32 by webs 58. It should further be noted at this point that the tubular wall 44 is cut away throughout a section 60 in the central portion of the housing 32, as shown in FIG. 3, in order that water in the axial bore 46 around the cable 20 will have access to a pressure sensing device generally designed by reference character 62 in FIG. 3. The pressure sensing device 62 will be described in detail below.

The housing 32 is journaled on the cable 20 by a main bearing 64, sometimes referred to as a thrust bearing, adjacent the forward end 66 of the housing 32, and a secondary bearing 68 adjacent the rearward end 36 of the housing. The secondary bearing 68 may merely comprise a split ring of plastic material suitably bonded to the tubular wall 44 to rather loosely surround the cable 20 and simply tend to retain the rearward end 36 of the housing 32 substantially centered around the cable 20.

As shown in FIGS. 3 and 6, the main or thrust bearing 64 comprises an inner race 70 and an outer race 72. The inner race 70 is in the form of a split ring having the half sections thereof rigidly secured around the outer surface of the cable 20 by bolts or screws 72. It should also be noted that a reinforcing ring 76 is preferably embedded in the cable 20 inwardly of the race 70 to reinforce the cable at this point and permit the race 70 to be firmly secured to the cable. The inner race 70 is provided with a circumferential groove 78 in the outer surface thereof of a size to loosely receive the outer race 72. The outer race 72 is in the form of a split ring rigidly secured to the adjacent portion of the tubular wall 44 by suitable fasteners 80. In a preferred construction, the inner race 70 is in the form of a light weight metal, such as an aluminum alloy, and the outer race 72 is in the form of a plastic material which may be the same as the material of construction of the housing 32 to provide good cooperating bearing surfaces between the inner and outer races.

As indicated above, the outer race 72 fits loosely in the groove 78 in the inner race 70 to provide complete freedom of turning of the outer race 72 on the inner race 70, and yet prevent any appreciable length-wise movement of the housing 32 on the cable 20. It may also be observed in FIG. 3, that the tubular wall 44 of the housing 32 may be bulged outwardly at 81 around the thrust bearing 64 to accommodate the structure of the bearing if necessary. It should further be noted at this point that both the thrust bearing 64 and the secondary bearing 68 provide sufficent clearance that the pressure of the water in which the paravane 30 is emersed will be transmitted lengthwise through the housing 32 into the cutaway section 60 of the tubular wall 44 during operation of the paravane.

As shown best in FIGS. 3 and 4, the pressure sensing device 62 comprises a tank or chamber 82 for containing air under pressure, and the air pressure is adjusted by means of a suitable valve 84 which may be, for example, of a construction similar to that used in automotive tubes and tires. An opening 86 is formed in the top of the tank 82 and is covered by an elastic material diaphragm 88. The diaphragm 88 may be formed of, for example, Neoprene, and the edges thereof are suitably secured in an air-tight relationship with the adjacent portions of the top of the tank 82, as by bonding. Upper and lower reinforcing plates 90 are secured to the top and bottom, respectively, of the central portion of the diaphragm 88 and form what may be considered a piston continually urged upwardly by the air pressure in the tank 82 and

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constantly urged downwardly by the water pressure in the housing 32. A rod 92 extends downwardly from the reinforcing plates 90 through an aperture 94 in the upper end of a bracket 96. The bracket 96 is rigidly secured to the bottom wall of the tank 82 and a limit pin 98 extends transversely through the lower end of the rod 92 to engage the upper end of the bracket 96 and limit the upward movement of the reinforcing plates 90.

A U-shaped yoke 100 has its lower, closed end 102, rigidly secured to the upper reinforcing plate 90, and the legs 104 of the yoke extend upwardly from the reinforcing plates 90 on opposite sides of the axial bore 46. It will be observed in FIG. 4 that the legs 104 of the yoke 100 are spaced sufficiently apart to not engage the cable 20 when the yoke is moved up and down with the movement of the reinforcing plates 90. The upper end of each of the yoke legs 104 is pinned to an arm 106 which extends substantially horizontally when the reinforcing plates 90 are in their neutral positions as illustrated in FIGS. 3 and 4. The forward end of each arm 106 is rigidly secured to a respective diving plane shaft 40 at the respective side of the housing 32. As shown in FIG. 5, each diving plane shaft 40 is journaled in a suitable bearing 108 in the respective side of the housing 32 with the center lines of the shafts 40 being aligned with the center line of the axial bore 46. Therefore, when the reinforcing plates 90 are moved either up or down, the arms 106 will be pivoted to turn the diving plane shafts 40 equal amounts and in the same directions to adjust the settings of the diving planes 38.

In a preferred structure, a U-shaped brace 110 (see FIG. 5) has its free ends rigidly secured to the diving plane shafts 40 and extends downwardly around the axial bore 46 out of interference with the cable 20. The brace 110 further assures simultaneous and equal movements of the diving planes, as in the event wear may develop in the connection of the yoke 100 to the arms 106. Further, a spring 112 is preferably anchored to the lower end portion of the brace 110 and an adjacent portion of the tank 82 to urge the diving planes 38 in directions for automatically raising the paravane 30 in the event of failure of the diaphragm 88. Also, the spring 112 prevents or minimizes an hysteresis effect in the diaphragm 88 by maintaining the diaphragm 88 in a known position and assures that a given change in the pressure differential across the diaphragm provides a given movement of the piston comprising the reinforcing plates 90. The spring 112 forms no part of the present invention, it being the invention of another, but is included herein to provide a complete disclosure of the best mode known to the present inventors.

Ballast, in the form of a lead weight 114 or the like, is secured in the lower portion of the housing 32 to further assure that the paravane will not turn or spin during movement through the water and that the diving plane shafts 40 will remain extended horizontally.

A suitable floatation material 116 preferably fills the housing 32, except for that portion 118 of the housing around the cutaway portion 60 of the tubular wall 44. The floatation material 116 may be of any desired type which will prevent the housing 32 from being filled with water, and, thus, increase the buoyancy of the paravane. However, the paravane will normally be slightly negatively buoyant.

Operation of preferred embodiment

As previously indicated, a plurality of paravanes 30 are used on a cable 20. Thus, before the cable 20 is placed in the water 22, the air pressure in the tank 82 of each paravane to be used is adjusted for the desired running depth of the paravanes and, hence, the desired depth of operation of the cable 20. As previously indicated, this air pressure may be easily adjusted by means of the valve 84 in each paravane. It may also be pointed out that when each tank 82 is pressurized to the desired degree, the diving planes 38 of the respective paravane will be turned into a diving attitude, since the air pressure in the tank will be opposed only by atmospheric pressure on the top of the respective diaphragm 88 and reinforcing plates 90. However, the stop pin 98 connected to the reinforcing plaes in each paravane will prevent the respective diaphragm 88 from being over stressed when the paravane is out of the water.

In use, the paravanes 30 are secured around the cable 20 as the cable 20 is paid out from the survey vessel 24. Each paravane is easily installed around the cable 20 by placing the upper and lower housing sections 48 and 50 around the cable with the outer bearing race 72 fitting in the inner bearing race 70 secured around the cable 20, and then attaching the fasteners 56. In this connection it may be noted that the inner bearing races are normally left intact on the cable 20 when the paravanes 30 are removed, although these inner bearing races can be removed in the event the cable needs repair.

As each paravane 30 is dropped into the water 22 with the cable 20, the diving planes 38 will be in their diving attitudes, such that the paravane will start trying to dive to the predetermined depth as regulated by the pressure in the air tank 82. When each paravane 30 is first placed in the water 22 behind the survey vessel 24, the wake provided by the survey vessel will sometimes make the paravane unstable and the paravane will tend to spin on the cable 20 for a short period of time. However, by virtue of the paravane being journaled on the cable 20, spinning of the paravane for a short period of time does not twist the cable. As soon as the paravane is moved rearwardly out of the wake provided by the survey vessel through a continued paying out of the cable 20, the paravane becomes stable in the water and oriented with diving plane shafts 40 extending horizontally. The diving planes 38 are then effective to urge the paravane downwardly to the predetermined depth of operation.

When the cable 20 has been paid out to the desired length with the paravanes 30 secured thereto, the pressure of the water surrounding each paravane will act on diaphragm 88 and on the upper reinforcing plate 90 and will force the reinforcing plates 90 to a neutral position when the pressure on the opposite sides of the diaphragm 88 becomes equal. At this point, the diving planes 38 will be extended horizontally, providing the diving plane shafts 40 are aligned with the center line of the cable 20 and the center line of the axial bore 46.

In the event a paravane 30 moves below the predetermined depth, as by action of water currents, the hydrostatic pressure of the water will become greater than the pressure in the tank 82; whereupon the reinforcing plates 90 will be moved downwardly and act through the yoke 100 and arms 106 to turn the diving planes 38 to elevating positions. The paravane 30 will therefore be moved upwardly by the reaction of the water 22 on the diving planes 38 until the paravane 30 reaches the desired depth, at which time the diving planes 38 will be returned to neutral positions. Conversely, in the event the paravane 30 moves upwardly above the predetermined operating depth, the pressure in the tank 82 will be greater than the hydrostatic pressure of the water 22 acting on diaphragm 88 and on the upper reinforcing plate 90, and the diving planes 38 will return to diving positions to return the paravane 30 to the desired operating depth.

The diaphragm 88 may be sized to control the operating depth of the paravane 30 to a plus or minus variation which will not affect the efficiency of the seismic survey being conducted. A two foot change in depth of the water 22 provides approximately a one pound per square inch variation in hydrostatic pressure. Thus, the area of the diaphragm 88 exposed to the hydrostatic pressure of the water 22 and to the pressure in the tank 82 will control the operating force available for application to adjust the diving planes 38. In one construction of paravane 30, a diaphragm 88 having an exposed area of seven square inches has been used, and with this size of diaphragm, the paravane will be maintained within plus or minus two feet of the desired operating depth in a surveying operation.

It will be understood that when each paravane 30 is maintained at a predetermined operating depth, the adjacent portion of the cable 20 will likewise be maintained at the desired depth, since any vertical movement of the paravane 30 will be reflected in the adjacent portion of cable 20, and vice versa. On the other hand, any twisting of the cable 20 will not effect the orientation of the paravane 30, since the cable 20 may twist and turn in the axial bore 46 of the paravane and will simply move the inner bearing race 70 with respect to the outer bearing race 72 and not turn the paravane. The paravane 30 will be virtually unaffected by currents, except when the paravane is in the wake of the survey vessel as referred to above, such that the paravane will remain oriented with the diving plane shafts 40 extending horizontally, and the diving planes 38 will effectively control the depth of operation of the paravane.

Since the cable 20 will be maintained at the desired operating depth by the paravane 30, the cable 20 may be maintained out of danger from being cut or damaged by another vessel cutting across astern of the survey vessel 24, and the cable 20 may be left in the water 22 throughout the night, with the seismic surveying operation being continued if desired. Further, since the cable 20 is maintained below surface turbulence, the noise picked up by the detectors in the cable is maintained at a minimum. In fact, in one test, a cable held at a predetermined depth by paravanes 30 experienced a 10:1 signal-to-noise reduction over a similar operation of the cable when the cable was supported by floats from the surface of the water.

Embodiment of FIG. 7

A slightly modified paravane structure 120 is schematically illustrated in FIG. 7. The paravane 120 is constructed in the same manner as the paravane 30 previously described, except that the ballast 122 for the paravane 120 is carried below the housing 32 by a web or support 124, rather than being in the housing as in the previous embodiment.

Placing the ballast farther below the cable 20, as in FIG. 7, tends to stabilize the orientation of the paravane which may tend to be upset by twisting of the cable 20, and is therefore desirable under some operating conditions. On the other hand, the exposed surfaces of the paravane 120 are greater below the center line of the cable 20 than above the center line of the cable 20, such that the paravane 20 is more subject to disorientation in response to cross currents than is the paravane structure disclosed in FIGS. 1 through 6.

Embodiment of FIG. 8

A still further modified paravane structure 130 is schematically illustrated in FIG. 8. The paravane 130 comprises a generally oval-shaped housing 132 secured symmetrically on the cable 20 by front and rear bearings 134. Each bearing 134 comprises an outer bearing race 136 rigidly secured to the inner surface of a tubular wall 138 of the housing 132, and an inner race 140 rigidly secured around the cable 20. The inner bearing race 140 has a circumferential groove 142 in the outer surface thereof loosely receiving the outer bearing race 136 in a manner similar to that previously described to effectively journal the housing 132 on the cable 20 and yet prevent lengthwise movement of the housing 132 along the cable.

The housing 132 is substantially hollow and includes an upper arm 144 and a lower arm 146. A cylinder 148 is suitably secured in the upper arm 144 in a fixed position and contains a piston 150 slidingly sealed therein. The piston 150 is continually urged in one direction by a spring 152, the compression of which may be adjusted by an adjusting bolt 154 threadedly secured in one end 156 of the cylinder 148. The opposite end of the piston 150 is exposed to the hydrostatic pressure of the water in which the paravane is emersed, since the water communicates with this face of the piston 150 through ports 158 formed in the walls of the arm 144. It may also be pointed out that the setting of the adjusting bolt 154 may be controlled through an opening 168 in the housing arm 144 which is normally covered by a removable plate 170.

A rod 172 projects from the piston 150 and has its free end 174 pinned to an arm 176. The arm 176 is in turn rigidly secured to a shaft 178 which carries diving planes 180 positioned on opposite sides of the housing arm 144.

The lower arm 146 of the housing 132 contains ballast 182 in the form of a lead weight or the like which tends to maintain the housing 132 oriented as shown in FIG. 8 with the diving plane shaft 178 maintained horizontally. It will also be apparent that the housing 132 may be formed in upper and lower sections for ease of assembly and disassembly of the paravane 130 on the cable 20 in a manner similar to that disclosed in FIGS. 1–6.

Before the paravane 130 is placed in water with the cable 20, the spring 152 is adjusted by the bolt 154 for the desired operating depth. Since the force exerted by the spring 152 will be virtually unopposed when the paravane 130 is out of the water, the piston 150 will be moved the maximum extent by the spring 152 to turn the diving planes 180 into a diving attitude when the paravane 130 is first placed in the water. Therefore, the paravane will quickly dive.

As the paravane 30 dives, the hydrostatic pressure imposed on the piston 150 through the ports 158 will increase to move the piston 150 against the spring 152 and gradually decrease the diving attitude of the diving planes 180. When the paravane 30 reaches the desired operating depth, the hydrostatic pressure of the water on the piston 150 will equalize the force provided by the spring 152 to place the piston 150 in what may be considered a neutral position and position the diving planes 180 in positions such that the paravane 130 will remain at said depth.

In the event the depth of operation of the paravane 130 is increased, as by force imposed on the cable 120, the hydrostatic pressure in the water will increase to force the piston in a direction to further compress the spring 152 and adjust the diving planes 180 into positions for raising the paravane. Conversely, in the event the paravane 130 is inadvertently moved upwardly in the water, the hydrostatic pressure will decrease and the spring 152 will move the piston 150 in a direction to place the diving planes 180 into diving positions and thereby lower the paravane back to the desired operating depth.

The bearings 134 prohibit a twisting motion of the cable 20 from being transmitted to spin or turn the housing 132, such that the paravane 130 will remain oriented in the water with the diving plane shaft 178 extending horizontally, and the diving planes 180 will remain in the proper positions for controlling the depth of operation of the paravane. On the other hand, any vertical forces imposed on the cable 20 will tend to raise or lower the paravane 130, and vice versa, such that the paravane 130 will maintain the adjacent portion of the cable 20 at the desired operating depth.

Embodiment of FIGS. 9 and 10

A portion of another modified paravane 200 is schematically illustrated in FIGS. 9 and 10. The paravane 200 comprises a hollow housing 202 which may be formed in sections joined along a line 204 for easy placement around the cable 20. The housing 202 is journaled on the cable 20 by bearing portions schematically illustrated at 206 in the forward and rear ends of the housing.

In this embodiment of the invention, a ring gear 208 is rigidly secured around the cable 20 within the housing 202 and is engaged by a plurality of equally circumferentially spaced pinions 210. Each pinion 210 is provided with flanges 214 on the opposite ends thereof of a size to overlap the respective ends of the ring gear 208 and prevent the housing 202 from moving lengthwise along the cable 20. Each pinion 210 is rigidly mounted on a shaft 216 having its opposite ends journaled in bearings 218. Each bearing 218 is in turn held in the desired position in the housing 202 by a plate 220 extending inwardly from the outer walls of the housing in any desired manner. The shaft 216 of one of the pinions 210 is connected by a belt drive 222 to the output shaft of a reversing electric motor 224. The motor 224 is rigidly secured in the housing 202 in any desired manner.

A pendulum 226 is suitably journaled on a shaft 228 supported in a horizontal position in the housing 202 by a pair of bearings 230 and supports 232, such that the pendulum 226 will tend to swing transversely with respect to the cable 20 at any time the angular orientation of the housing 202 is changed. As schematically illustrated in FIG. 10, the pendulum 226 is connected to a source of electrical energy 234, such as a battery. Also, opposed contacts 236 and 238 are positioned on opposite sides of the pendulum 226 and are connected to the forward and reverse inputs 240 and 242, respectively, of the reversing motor 224.

A complete paravane 200 will also include diving planes and a pressure responsive device therein similar to the corresponding structure previously described in connection with FIGURES 1–6, or 8 to control the operating depth of the paravane.

In operation of the paravane 200, the pendulum 226 will remain in a vertical position as long as the housing 202 is properly oriented, that is, as long as the housing 202 is not turned on the cable 20. If the housing 202 starts turning in one direction, the pendulum 226 will contact one of the contacts 236 or 238 to energize the motor 224 in one direction. The motor 224 will in turn drive the pinion 210 connected thereto in a given direction. The respective pinion 210 will in turn engage the ring gear 208 and return the housing 202 to the proper angular orientation. In the event the housing 202 starts turning in the opposite direction the pendulum 226 will contact the opposite contacts 236 or 238 and energize the motor 224 in an opposite direction to return the housing 202 to the desired position through the driving engagement of the pinion 210 connected to the motor 224. The remaining pinions 210 act as idlers and equalize the forces imposed on the ring gear 208.

Embodiment of FIG. 11

Still another paravane structure 200 is schematically illustrated in FIG. 11. The paravane 300 comprises an upper housing section 302 and a lower housing section 304 interconnected by forward and rear tubular portions 306. The tubular portions 306 are journaled around the cable 20, as by bearings 134 of the type shown in FIG. 8. The lower housing section 304 contains a suitable ballast 308 which will retain the lower housing section 304 extending downwardly below the cable 20 and will retain the upper housing section 302 extending upwardly above the cable 20.

The upper housing section 302 contains walls forming an inlet passageway 310 communicating with the forward end 312 of the housing; a rearwardly and upwardly extending passageway 314 communicating with the passageway 310 and the outer surface of the housing section 302; and a downwardly and rearwardly extending passageway 316 communicating with the inlet passageway 310 and the outer surface of the housing section 302. A vane 318 is rotatably secured in the housing section 302 by a shaft 320 in a position to selectively at least partially close off the passageways 314 and 316 from the inlet passageway 310. In other words, referring to FIG. 11, when the vane 318 is turned counterclockwise, the passageway 314 will be at least partially closed off, and when the vane 318 is turned clockwise, the passageway 316 will at least be partially closed from the inlet passageway 310. The shaft 320 is suitably connected to a pressure sensing device as of the type shown in either FIG. 3 or FIG. 8, such that the vane 318 will be turned by variations in the hydrostatic pressure of the water in which the paravane 300 is operating.

In operation of the paravane 300, the pressure sensing device will turn the shaft 320 to turn the vane 318 into a position partially closing off the passageway 316 from the inlet 310 when the paravane 300 is first placed in the water. Thus, as the paravane 300 is towed through the water, the water flowing through the inlet passageway 310 and then upwardly and rearwardly through the passageway 314 will cause a reaction on the paravane to make the paravane dive toward the predetermined depth of operation. When the predetermined depth is reached, the vane 318 will have been moved to a neutral position as illustrated in FIG. 11. In the event the paravane 300 is lowered from the desired operating depth, the vane 318 will be turned by the pressure sensing device to partially close off the passageway 314 from the inlet passageway 310. The water then flowing through the inlet passageway 310 will be directed downwardly by the passageway 316 and cause a reaction force for raising the paravane 300 back to the desired operating depth.

From the foregoing it will be apparent that the present invention will effectively maintain a marine seismic detector cable at a predetermined depth in water as the cable is being towed through the water. The noise received by the detectors in the cable will be substantially reduced over previous operating techniques and the cable may be left in the water during the night and, in fact, the seismic surveying operations may be continued throughout the night if desired. The paravane provided by this invention will not be affected by twisting of the cable, as when the direction of the surveying vessel is changed, such that the means for controlling the depth of the paravane will remain oriented in the proper position and remain effective for controlling the depth, even as the cable is turned.

Changes may be made in the combination or arrangement of parts or elements as heretofore set forth in the specification and shown in the drawings, it being understood that changes may be made in the embodiments disclosed without departing from the spirit and scope of the invention as defined in the following claims.

What is claimed is:

1. A paravane for a seismic cable adapted to be towed substantially horizontally through water, comprising: a housing having a bore means along its length thereof, said bore means of a size to receive said seismic cable and allow rotation of said seismic cable without rotation of said housing while transmitting upward and downward forces between the housing and the adjacent portions of said cable; bearing means for securing the housing onto said seismic cable against movement of said housing along said cable; and means carried by the housing including at least one vane for maintaining the paravane at a predetermined depth in the water as the paravane is moved through the water by the cable and for counteracting upward, downward and turning forces imposed on the housing, whereby the paravane maintains the adjacent portions of the said seismic cable at said predetermined depth.

2. A paravane as defined in claim 1 wherein said last mentioned means includes:
  ballast carried by the housing below the cable to counteract turning forces imposed on the housing;
  depth sensing means carried by the housing; and
  adjustable diving means carried by the housing, engaging the water and connected to the depth sensing means for varying the depth of the paravane in response to the depth sensing means.

3. A paravane as defined in claim 2 characterized further to include:

vertical and horizontal fixed fins secured to the exterior of the housing for further counteracting turning forces imposed on the housing.

4. A paravane as defined in claim 2 wherein said adjustable diving means comprises:

diving planes rotatably secured to the opposite sides of the housing; and

means interconnecting the diving planes for uniform adjustment of the diving planes in response to the depth sensing means.

5. A paravane as defined in claim 2 wherein said housing has a forward end and a rearward end, wherein said adjustable diving means comprises:

walls in the housing forming an inlet passageway for water at the forward end of the housing, a rearward and upwardly extending passageway communicating with the inlet passageway and the exterior of the housing, and a rearward and downwardly extending passageway communicating with the inlet passageway and the exterior of the housing; and

said vane connected to the depth sensing means and pivotally secured in the housing in a position to selectively at least partially close off said upwardly and downwardly extending passageways to control the flow of water therethrough as the housing is moved through the water.

6. A paravane for a seismic cable adapted to be towed through water, comprising:

an elongated housing having an upper portion, a lower portion, a forward end and a rearward end, and having an axial bore extending therethrough of a size to receive the cable;

bearing means rotatably securing the housing on the cable while preventing lengthwise movement of the housing along the cable;

stabilizing means carried by the housing to prevent the housing from rotating while being towed through the water by the cable; and

depth control means carried by the housing for maintaining the housing, and hence the adjacent portion of the cable, at a predetermined depth in the water as the cable and housing are towed through the water.

7. A paravane as defined in claim 6 wherein said housing comprises an upper section, a lower section, and fasteners securing the upper and lower sections around the cable.

8. A paravane as defined in claim 6 wherein said bearing means comprises:

an inner race rigidly secured around the cable; and

an outer race journaled on the inner race and rigidly secured to the housing within said axial bore.

9. A paravane as defined in claim 8 wherein said inner race is secured in said axial bore adjacent the forward end of the housing.

10. A paravane as defined in claim 8 wherein said inner race comprises a ring having a circumferential groove in the outer periphery thereof; and

said outer race comprises a ring of a material different from the inner race ring and sized to slidably fit in said circumferential groove.

11. A paravane as defined in claim 10 wherein said housing comprises an upper section and a lower section and fasteners for securing said sections around the cable, and wherein

said outer race ring is formed in the two sections, one section being secured to the upper housing section and the other section being secured to the lower housing section.

12. A paravane as defined in claim 6 wherein said stabilizing means includes ballast carried by the lower portion of the housing below the cable.

13. A paravane as defined in claim 12 wherein the ballast is secured in the lower portion of the housing and wherein the area of the surfaces of the housing below the center line of said bore exposed to the water are equal to the area of the surfaces of the housing above the center line of said bore exposed to the water.

14. A paravane as defined in claim 13 characterized further to include fixed vertical and horizontal fins secured to the outer surface of the housing.

15. A paravane as defined in claim 12 wherein said ballast is positioned below the housing.

16. A paravane as defined in claim 6 wherein said depth control means includes:

horizontally extending shafts journaled in the opposite sides of the housing;

a diving plane rigidly secured on each shaft; a piston reciprocally carried by the housing having one end thereof exposed to the water through which the paravane is towed;

adjustable elastic means engaging the piston whereby the piston will move in response to changes in depth of the paravane above and below a predetermined depth; and

a linkage connecting the piston to said shafts for turning said shafts and controlling the settings of the diving planes.

17. A paravane as defined in claim 16 wherein said piston is supported in the housing for vertical movement with said one end thereof exposed to said axial bore, and wherein

the diameter of said axial bore is larger than the diameter of the cable, whereby the water through which the paravane is moving contacts said one end of the piston.

18. A paravane as defined in claim 16 wherein said shafts are aligned with the center line of said axial bore, and wherein

said linkage includes a U-shaped yoke having its free ends extending upwardly and being sized to move vertically without interference with the cable;

means connecting the closed end of the yoke to the piston for vertical movement of the yoke with the piston; and

an arm pivotably secured to each of the free ends of the yoke and rigidly secured to the shaft on the respective side of the cable for turning the shafts upon movement of the piston.

19. A paravane as defined in claim 18 characterized further to include a semi-circular shaped brace loosely encircling one-half of the cable and having its ends rigidly secured to the shafts to assure equal movement of the diving planes.

20. A paravane as defined in claim 6 wherein said housing is hollow and characterized further to include:

flotation material filling the available space in the housing not required for said bearing means, stabilizing means and depth control means.

21. A paravane as defined in claim 9 wherein a secondary bearing is secured in the axial bore loosely around the cable adjacent the rearward end of the housing.

22. Apparatus for maintaining a seismic cable at a predetermined depth as the cable is being towed substantially horizontally through water, comprising:

a plurality of paravanes secured in spaced relation along the cable, each of said paravanes comprising:

a housing having a bore means along its length thereof, said bore means of a size to receive said seismic cable and allow rotation of said cable without rotation of said housing while transmitting upward and downward forces between said housing and adjacent portions of said cable; bearing means for securing said housing onto said cable against movement of said housing along said cable; and

means carried by the housing including at least a vane for maintaining the paravane at a predetermined depth in the water as the paravane is moved through the water by the cable and for counteracting upward, downward and turning forces imposed on the

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housing, whereby the paravane maintains the adjacent portion of the cable at said predetermined depth.

23. Apparatus for maintaining a seismic cable at a predetermined depth as the cable is being towed through water, comprising:

a plurality of paravanes secured in spaced relation along the cable, each of said paravanes comprising:
  an elongated housing having an axial bore extending therethrough of a size to receive the cable;
  bearing means rotatably securing the housing on the cable while preventing lengthwise movement of the housing along the cable;
  stabilizing means carried by the housing to prevent the housing from rotating while being towed through the water by the cable; and
  depth control means carried by the housing for maintaining the housing, and hence the adjacent portion of the cable, at a predetermined depth in the water as the cable and housing are towed through the water.

24. A paravane for a seismic cable adapted to be towed through water, comprising:

an elongated housing having an axial bore therethrough of a size to receive the cable;
a ring gear rigidly secured around the cable;
at least one pinion journaled in the housing in a position to engage the ring gear and turn the housing around the cable;
reversing motor means in the housing drivingly connected to said pinion;
a source of electrical energy;
a pendulum secured in the housing for swinging when the housing turns on the cable and being connected to the source of electrical energy;
contacts in the housing on the opposite sides of and positioned to be selectively engaged by the pendulum upon turning of the housing on the cable, said contacts being connected to the forward and reverse inputs of the reversing motor for maintaining the housing in a predetermined angular orinetation upon twisting of the cable; and
depth control means carried by the housing for maintaining the housing, and hence the adjacent portion of the cable, at a predetermined depth in the water as the cable and housing are towed through the water.

25. A paravane for an elongated member adapted to be towed substantially horizontally through water, comprising: a housing having a bore means along its length thereof, said bore means of a size to receive said elongated member and allow rotation of said elongated member without rotation of said housing while transmitting upward and downward forces between the housing and the adjacent portions of said elongated member; bearing means for securing the housing onto said elongated member against movement of the housing along said elongated member; and, means carried by the housing including at least a vane for maintaining the paravane at a predetermined depth in the water as the paravane is moved through the water by said member and for counteracting upward, downward and turning forces imposed on the housing, whereby the paravane maintains the adjacent portion of said member at said predetermined depth.

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FERGUS S. MIDDLETON, *Primary Examiner.*

MILTON BUCHLER, *Examiner.*

T. M. BLIX, *Assistant Examiner.*

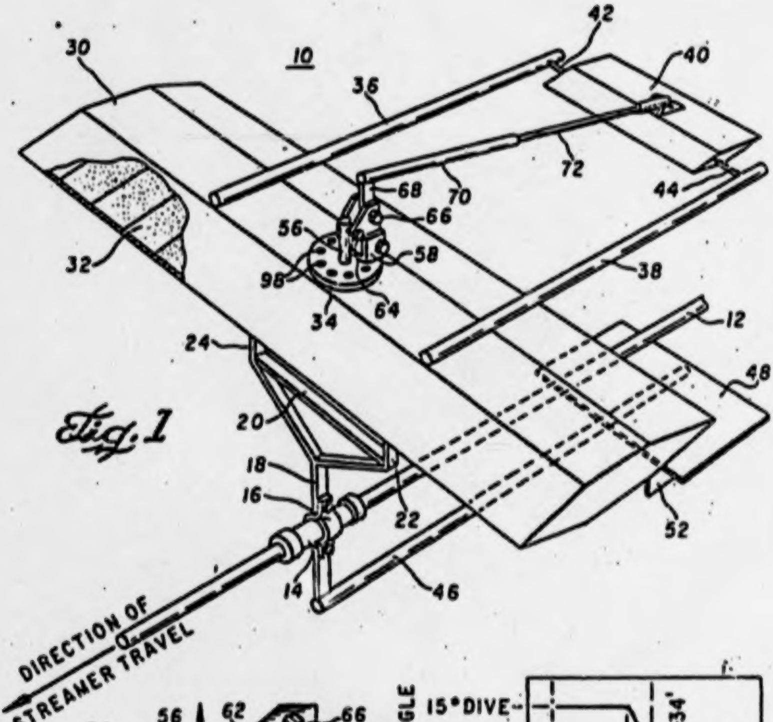
APPENDIX E

E-1

March 12, 1968 B. M. BAKER 3,372,666

DEPTH CONTROLLER

Filed Oct. 24, 1965 2 Sheets-Sheet 1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DIRECTION OF STREAMER TRAVEL

Fig. 1

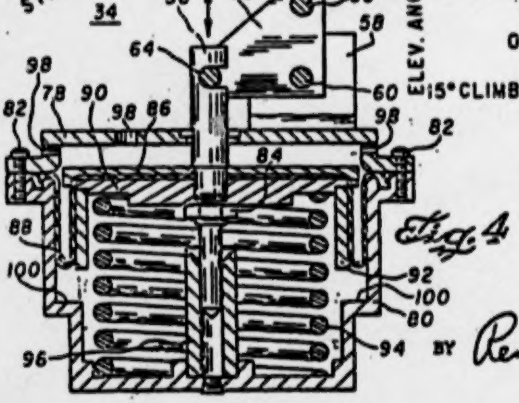
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Fig. 4

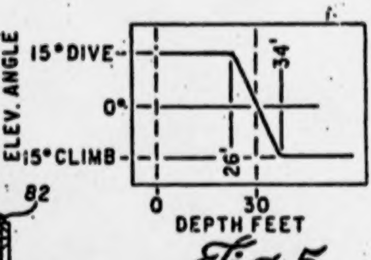

Fig. 5

INVENTOR
Buford M. Baker

BY René E. Grossman

ATTORNEY

E-2

March 12, 1968 **B. M. BAKER** 3,372,666

DEPTH CONTROLLER

Filed Oct. 24, 1965 2 Sheets-Sheet 2

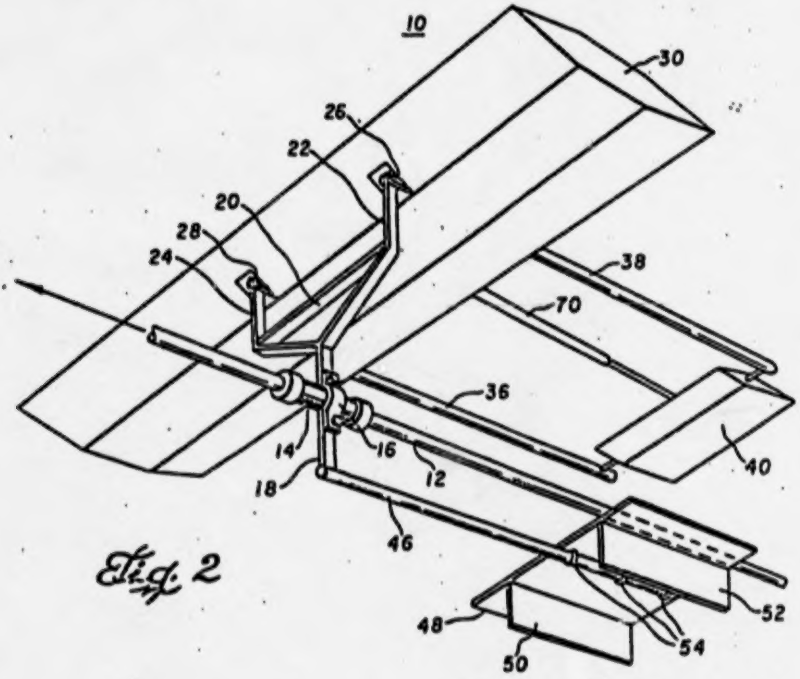
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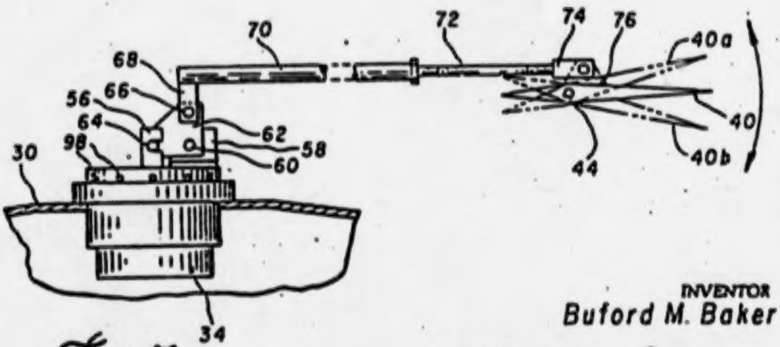
Fig. 2


70
72
74
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40a
68
66
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64
62
58
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98
30
40
44
40b
34

Fig. 3

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E-3

United States Patent Office

3,372,666
Patented Mar. 12, 1968

3,372,666
DEPTH CONTROLLER

Buford M. Baker, Dallas, Tex., assignor to Texas Instruments Incorporated, Dallas, Tex., a corporation of Delaware

Filed Oct. 24, 1965, Ser. No. 504,724
5 Claims. (Cl. 114—235)

ABSTRACT OF THE DISCLOSURE

Apparatus for controlling the depth of a device such as a towed streamer in a fluid medium. A pressure responsive sensor is connected to a wing for controlling the variance of the deflection angle of an elevator and the wing in a linear manner related to the depth of the sensor within a predetermined range of depths and in a constant manner at all depths above and below the predetermined range.

This invention relates to a depth controller and more particularly to an apparatus for controlling the depth of a towed streamer or other such device in a fluid medium.

Streamers constructed so as to be approximately neutrally bouyant and containing sensing elements for receiving acoustic energy propogated through the water are widely used, such as for seismic exploration for oil. It has been found that if the front end of a streamer is controlled by appropriate means to maintain a certain depth, and the streamer is carefully adjusted as to weight and size to be nearly neutrally bouyant, then the streamer will maintain a near constant depth throughout its length, in most cases, if it is of rather short length (for example, less than 2400 feet). If the streamer is as long as 8000 feet, for example, it is extremely difficult to maintain a reasonably constant depth throughout its length by weight and bouyancy adjustment alone. This is because a streamer cannot be made exactly bouyant as they are usually oil filled, and temperature variations cause changes in the density of the oil, thereby changing the bouyancy. Also, changes in the salinity of the sea water, from one location to another, cause variations in the bouyancy. This is an especially large effect off-shore from the mouths of rivers where the fresh water from the rivers dilutes the sea water.

It is therefore an object of this invention to provide an apparatus for maintaining a body at a predetermined depth, the depth being sensed by a pressure sensor assembly included within the apparatus.

Another object of the invention is to provide an apparatus which includes an elevator means that is responsive to an output from a pressure sensing device.

Yet another object of the invention is to provide an apparatus which seeks a predetermined depth at a maximum rate and then maintains that depth.

Other objects and features of the invention will become more readily understood from the following detailed description and appended claims when read in conjunction with the accompanying drawings, in which like reference numerals designate like parts throughout the figures thereof, and in which:

FIGURE 1 is a perspective view of the depth controller viewed from the top;

FIGURE 2 is a perspective view of the depth controller viewed from the bottom;

FIGURE 3 is a view of the interconnection of the shaft of the pressure sensor assembly with the elevator of the controller;

FIGURE 4 is a cross-section of the pressure sensor assembly;

FIGURE 5 shows the relationship of elevator angle to depth in the water.

Referring now to FIGURES 1 and 2, the depth controller is indicated generally by the reference numeral 10. To this depth controller is attached a streamer 12 having a metallic sleeve 14 as an integral part thereof. The metallic sleeve is attached to the point on the streamer for maintaining a portion of the streamer at a predetermined depth, for example, at a depth of 30 feet. The depth controller 10 is connected to the streamer 12 by means of an attaching clamp 16 which surrounds the sleeve 14 and is bolted to a metallic Y support bracket 18. Across the upper portion of the support bracket is a bar 20 which provides additional support and strength for the Y bracket. The ends 22 and 24 of the Y support bracket are connected to hinges 26 and 28, respectively (FIGURE 2), which allow wing member 30 to pivot an amount dependent upon the angle of deflection of the elevator 40.

Wing member 30, in this embodiment, is hollow and made of plywood although it can be made of any other suitable material. Included in the outer sections of the wing are styrofoam blocks 32 to add bouyancy or flotation to same. In the center section of the wing is a pressure sensor assembly 34, the structure of which will be described below. Elevator booms 36 and 38 are attached to wing 30 at one end, while each of the other ends provide support for elevator 40. The elevator 40 is connected to each of the elevator booms 36 and 38 by hinges 42 and 44, respectively.

Since the wing 30 is buoyant (due to its plywood material and the styrofoam blocks in the wing), it is necessary to provide additional weight and stability below the streamer 12 to maintain wing 30 in a horizontal position. This weight is provided by steel tube 46 attached to the end of the metallic Y support bracket under the streamer. On the other hand, the stability is provided by a horizontal stabilizer or tail assembly 48 which has attached to it two rudders 50 and 52. The tail assembly 48 and rudders 50 and 52 may be made of a suitable material, such as plywood. The tail assembly is attached to the weighted steel tube 46 by means of clamps 54. By use of the weighted tube and the tail assembly, the necessary weight and horizontal stability is provided for wing member 30.

FIGURE 3 shows the apparatus necessary to translate the output of shaft 56 of pressure assembly 34 to elevator 40. As was stated previously, the pressure assembly 34, in this embodiment, sits in the center portion of wing 30 (as shown in FIGURE 2) with shaft 56 extending through the wing. Attached to bracket 58 and fixed at point 60 is a bell crank 62. This crank is secured at points 64 and 66 to shaft 56 and tang 68, respectively. The tang acts as a spacer to transfer the motion at point 66 to the control rod 70. Since point 60 is fixed and points 64 and 66 are free to rotate, the vertical motion of shaft 56 will be transmitted into a substantially horizontal motion at point 66, this motion being subsequently transferred by the tang 68 to the control rod 70. One end of extension rod 72 is attached to control rod 70 and the other end of said extension rod is coupled to an extension rod end 74. This rod end has a hole in it which allows the elevator hinge to pass therethrough. As shown in FIGURE 1, hinges 42 and 44 allows the elevator 40 to rotate around the points attached to the elevator booms 36 and 38. Accordingly, if shaft 56 were to move downward from its midpoint position, this motion would be transmitted to elevator 40 which would, in turn, move the elevator upward to a position such as that shown at 40a. An upward movement by shaft 56 would have the reverse effect and cause the elevator to move to a position such as that shown in 40b. Thus the control rod and pressure sensor assembly determine the angle of deflection of the elevator 40.

E-4

FIGURE 4 shows the pressure sensor assembly 34 which senses the depth of depth controller 10. The pressure sensor assembly cover 78 is attached to the barrel 80 by means of screws 82. Extending through the center of the assembly is the shaft 56 which, in combination with nut 84, bolts together the piston cap 86, the elastic diaphram 88 and the piston 90. Attached to the piston (by epoxy cement, for example) is a piston skirt 92. A precompressed spring 94 is lodged between the piston 90 and the floor of the barrel 80. A guide 96 directs the motion of shaft 56. Inlet ports 98 enable water to enter into the upper portion of the barrel to establish the hydrostatic pressure. The downward motion of the shaft 56 is limited by mechanical stop 100, whereas the upward movement of the shaft is limited by the top portion of piston cap 86 coming in contact with the bottom portion of pressure assembly cover 78.

FIGURE 5 is a graphical representation of the elevator angle deflection with depth and will be discussed in connection with the operation of the device hereinbelow.

In operation, the pressure sensor assembly 34 senses the depth of the water and also furnishes the forces necessary to position the elevator 40. The spring 92 is precompressed during the assembly of the pressure sensing device. Therefore, at the surface of the water, the spring 92 is pushing the piston assembly against the lower surface of the assembly cover 78. With the shaft 56 thus at its uppermost position, the elevator 40 will be in position 40*b* (FIGURE 3) which will be the maximum dive angle of the device. This can be seen in FIGURE 5, for at zero depth (that is at the water surface), the elevator 40 will have a 15 degree or maximum dive angle. As the depth controller begins to dive, water will enter through the inlet ports 98, thus allowing the hydrostatic pressure to be transmitted to the interior of the barrel, whereupon this pressure exerts a force against the top of the piston cap 86 and the spring 94. Downward movement of the piston does not occur, however, until there is sufficient hydrostatic pressure (depth) to overcome the initial precompression force of the spring. As can be seen in FIGURE 5, the piston, and therefore the elevator, will not move until a depth of 26 feet is reached; that is, at that depth the hydrostatic pressure of the water equals the precompression force of the spring. It should be observed that the particular forces being produced upon the elevator are also transmitted through the elevator booms 36 and 38 to the wing member 30, thus forcing the wing into a dive or climb angle in accordance with the position of the elevator 40.

As the hydrostatic pressure of the water exceeds the initial precompression of the spring, the piston will be forced downward, thus producing a downward motion of shaft 56. As shaft 56 is forced downward, the elevator angle will be reduced until at a 30 foot depth the piston is at its mid-position in the barrel and the elevator angle will be zero degrees (as shown in FIGURE 5). The wing member 30 will also be at zero angle to the water flow and there will be no diving force exerted. The streamer 12 will then be towed at this 30 foot depth.

If the streamer 12 is heavier than neutrally bouyant, the depth controller 10 will be forced to a depth greater than 30 feet. As an example, assume that the streamer 12 sinks to 40 feet. At this depth, the hydrostatic pressure will be in excess of the spring tension in spring 94 and the piston assembly 90 will be at its maximum downward position. This position corresponds to the point at which piston skirt 92 comes into contact with the mechanical stop 100. At this depth, the shaft 56 will be in its maximum downward position and the elevator 40 will be in position 40*a* (FIGURE 3), the maximum climb angle. Therefore, the depth controller will climb until it reaches that depth at which the force of the spring is sufficient to overcome the hydrostatic pressure of the water and move the piston skirt 92 off of the mechanical stop 100. This point corresponds to a depth of 34 feet (as shown in FIGURE 5), and as the streamer 12 and depth controller continue to climb, the decreased water pressure on the piston 90 causes a reduction of elevator angle until at 30 feet the piston assembly will again be in the mid-position, with the elevator angle correspondingly being at zero degrees. Wing member 30 will be at a zero degree angle to the water flow and there will no longer be a climbing force exerted.

It should be noted that the depth controller 10 automatically reaches that climbing or diving angle which will counterbalance the force acting upon it. It should be further noted that the piston motion is not proportional to depth (as can be seen in FIGURE 5). The depth controller will climb or dive at a maximum angle (whichever is necessary) to approach the desired depth. This is assured in shallow water by the precompression of the spring 94 exceeding the hydrostatic pressure, thereby maintaining the shaft 56 at its maximum upward position (which corresponds to the maximum elevator dive angle). If the device is too deep in the fluid medium, the hydrostatic pressure of the medium will substantially exceed the tension of the spring and force the piston and shaft against the mechanical stop 100 to its maximum downward position, which corresponds to the maximum elevator climb angle. This means of turning the elevator 40 through a full range of 30 degrees over a depth change of 8 feet results in control of the depth very close to the desired 30 foot depth, even though the streamer 12 is either too heavy or too light.

Although the present invention has been shown and illustrated in terms of a device for controlling a streamer at a 30 foot depth, it will be apparent that the device can be made to control a body at any desired depth by selecting a suitable spring for the pressure sensor assembly. Also, although the device has been described as being useful for maintaining predetermined depths for seismic streamer applications, it will be further apparent that the depth controller can be used for controlling the towed depth of other equipment, such as sonar transducers and sensors for measuring temperature, salinity, light intensity, and the like.

It is to be understood that the form of the invention, herewith shown and described, is to be taken as a preferred example of the same, and that various changes in the shape, size and arrangement of parts may be resorted to without departing from the spirit and scope of the invention as defined in the appended claims.

What is claimed is:

1. A depth controller for maintaining a body at a predetermined depth in a fluid medium, comprising:

(a) means responsive to the pressure of said medium for generating a control mechanical output linearly related to the depth of said body within a predetermined range of depths and for generating a constant mechanical output at all depths above and a constant mechanical output at all depths below said predetermined range, said means comprising a barrel and a piston having a range of travel within said barrel limited in one direction by a cap on one end of said barrel and in the other direction by a shoulder within said barrel and spaced from the other end of said barrel and

(b) variable deflection means responsive to said mechanical outputs for controlling the depth of said body in said medium, the angle of deflection of said variable deflection means being proportional to said control or said constant mechanical outputs.

2. A depth controller for maintaining a body at a predetermined depth in a fluid medium, comprising:

(a) means responsive to the pressure of said medium for generating a control output linearly related to the depth of said body within a predetermined range of depths and for generating a constant output at all depths above and a constant output at all depths below said predetermined range said means comprising a barrel and a piston having a range of travel within said barrel limited in one direction by a cap on one end of said barrel and in the other direction by a shoulder within said barrel and spaced from the other end of said barrel,

(b) elevator means having a variable angle of deflection responsive either to said control output or the constant outputs for varying its angle of deflection when said body deviates from said predetermined depth, and

(c) wing means having a variable angle of deflection responsive to the deflection of said elevator means for controlling the depth of said body.

3. A depth controller for maintaining a body at a predetermined depth in a fluid medium, comprising:

(a) means responsive to the pressure of said medium for generating an output linearly related to the depth of the body within a predetermined range of depths and also responsive to the pressure of said medium for generating a constant output at all depths above and a constant output at all depths below said predetermined range,

(b) control means responsive either to said output or said constant outputs of said first-mentioned means,

(c) elevator means having a variable angle of deflection responsive to said control means for varying its angle of deflection when said body deviates from said predetermined depth,

(d) wing means having a variable angle of deflection responsive to the deflection of said elevator means,

(e) support means, said support means being pivotally connected to said wing means, and

(f) stabilizing means connected to said support means for maintaining said wing means in a horizontal position.

4. A depth controller for maintaining a body at a predetermined depth in a fluid medium, comprising:

(a) a pressure sensor means having:

(1) a movable shaft with a maximum and minimum output and varying linearly therebetween, said output being indicative of the depth of said body in said medium,

(2) a piston assembly responsive to the pressure of the medium, said assembly being attached to said shaft,

(3) a precompressed spring exerting a force against said piston assembly,

(b) control means responsive to said output,

(c) elevator means having a variable angle of deflection responsive to said control means for varying its angle of deflection when said body moves from said predetermined depth,

(d) bouyant wing means having a variable angle of deflection responsive to the deflection of said elevator means,

(e) support means, said support means being pivotally connected to said wing means, and

(f) stabilizing means connected to said support means for maintaining said wing means in a horizontal position.

5. A depth controller for maintaining a towed body at a predetermined depth in a fluid medium comprising:

(a) a cylinder having a piston therein,

(b) a compression spring forcing said piston against the top of said cylinder,

(c) a flexible diaphragm means for sealing said piston to said cylinder while admitting movement of said piston within said cylinder,

(d) a structure forming a flow channel leading into said cylinder to force said piston against said spring,

(e) stop means comprising a stepped diameter in said cylinder providing a shoulder facing the top of said cylinder for limiting travel of said piston into said cylinder to a linear range of said spring, and

(f) means connected to said body and responsive to the position of said piston in said cylinder to control the attitude of said body.

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MILTON BUCHLER, *Primary Examiner.*

T. M. BLIX, *Assistant Examiner.*

APPENDIX F

F-1

JOD

TI MEMORANDUM
DATE: August 5, 1965

TO: **Buford Baker**

COPY: **Personnel File - Buford M. Baker**

FROM: Harold Levine

SUBJECT: Invention Disclosure

This will acknowledge receipt by this department of your disclosure dated July 23, 1965, entitled "DEPTH CONTROLLER."

For your records, this disclosure has been assigned case number TI-2244.

Your disclosure will be taken up for further consideration as soon as possible, but in order to assure appropriate action thereon, it is important that this department be promptly notified in advance of the first date that a public disclosure (e.g., public use or publication) or sale of an item embodying this invention is to take place.

HAROLD LEVINE
Patent Department

sr
HL/sr

DEFENDANT'S
EXHIBIT
NO. 35

F-2

TO: JIM DIXON

HOPE WE DON'T KILL THIS.

B Baker

RECEIVED
JUL 2[illegible]
TI PATENT DEPARTMENT

F-3

TI CASE NO. 2214

PATENT DISCLOSURE INSTRUCTION AND COVER SHEET

(PLEASE PRINT OR TYPE)

DATE SUBMITTED 23 July 1965

1. INVENTION DESCRIPTIVE TITLE: DEPTH CONTROLLER

2. SUBMITTED BY:

(1) NAME Buford (FIRST) Morris (MIDDLE) Baker (LAST)
DEPARTMENT Engr.
EXT. NUMBER
U.S. CITIZEN ☐ YES ☐ NO

☐ APP. (DALLAS)
☐ SCD
☐ CASE
☐ M&C (DALLAS)
☐ APP. (HOUSTON)
☒ SSD
☐ M&C (ATTLEBORO)
☐ OTHER

RESIDENCE 3975 Crown Shore Drive (STREET) - Dallas, (CITY) Dallas, (COUNTY) Texas (STATE)

(2) NAME (FIRST) (MIDDLE) (LAST)
DEPARTMENT
EXT. NUMBER
U.S. CITIZEN ☐ YES ☐ NO

☐ APP. (DALLAS)
☐ SCD
☐ CASE
☐ M&C (DALLAS)
☐ APP. (HOUSTON)
☐ SSD
☐ M&C (ATTLEBORO)
☐ OTHER

RESIDENCE (STREET) (CITY) (COUNTY) (STATE)

(IF MORE THAN TWO INVENTORS, PLEASE ADD ADDITIONAL SHEET GIVING ABOVE INFORMATION)

3. INVENTION RELATES TO: (CHECK ONE)

INDUSTRIAL PRODUCTS
☐ TEST INSTRU.
☐ RECORDERS
☐ DATA/SCIENTIFIC INSTRU.

SEMICONDUCTORS
☐ NEW DEVICES
☐ MATERIAL OR FAB
☐ CIRCUITS

GEOPHYSICAL
☐ DATA PROCESSING
☒ EQUIPMENT
☐ EXPLORATION MTHDS.

OTHER
☐ MILITARY EQUIP
☐ INFRARED DEVICES
☐ ELEC. CIRCUITS
☐ ELEC. DEVICES
☐ MECH. DEVICES
☐ OPTICS
☐ CHEMICAL/MATERIALS

4. INVENTION DISCLOSED OR DESCRIBED IN ENGINEERING NOTEBOOK NO. PAGES

5. DATE INVENTION CONCEIVED March 1965
DATE FIRST SKETCH OR DRAWING MADE April 1965 — NOT YET STARTED ☐
DATE CONSTRUCTION OR MODEL STARTED April 1965 — NOT YET COMPLETE ☐
DATE CONSTRUCTION OR MODEL COMPLETED April 1965 — NOT YET STARTED ☐
DATE TESTING STARTED May 1965 — NOT YET COMPLETE ☐
DATE SUCCESSFUL TESTING COMPLETED June 1965
SUCCESSFUL TESTING RECORDED IN ENGINEERING NOTEBOOK NO. PAGE(S)
AND WITNESSED BY 1) ON 19 2) ON 19

6. HAS THERE BEEN ANY EXPERIMENTAL USE OF THE INVENTION? ☐ YES ☒ NO
HAS THERE BEEN ANY SALE OR PRODUCTION USE OF THE INVENTION? ☐ YES ☒ NO
IS SALE OR PRODUCTION USE SCHEDULED? ☒ YES ☐ NO

7. IF ANY ANSWERS IN 6 ARE "YES," EXPLAIN, GIVING DATES July, 1965

8. HAS THERE BEEN A DISCLOSURE OF THE SUBJECT MATTER OF THIS INVENTION IN ANY PUBLICATION, PROPOSAL, OR REPORT, OR IS SUCH DISCLOSURE ANTICIPATED? ☐ YES
IF YES, IDENTIFY:

RECEIV
2
TI PATENT DEPARTMENT

TI-[illegible]

F-4

(a) The Performance of the Experimental [illegible]
Contract or Subcontract: ☐ Yes ☒ No

(b) The performance of Any Experimental, Developmental, or Research Work Relating to the Subject Matter of a Government Contract and which was Done upon the Understanding in writing that a Contract Would be Awarded: ☐ Yes ☒ No

10. Numbers of Contracts Referred to in 9: (a)________________(b)________________

11. Is the Invention Embodied in Any Material or Product Furnished or To Be Furnished under a Government Contract or Subcontract? ☐ Yes ☒ No

12. Numbers of Contracts or Subcontracts Referred to in 11:________________

13. Prepare and attach to this cover sheet a **complete** written disclosure of your invention including any sketches, diagrams, drawings, prints, etc. which will aid in understanding this invention. The outline below should be followed in writing the disclosure:

    (1) Brief Discussion of Problem Solved by Invention

    (2) Presentation and Discussion of Known Prior Art, Including Manner in which Others Have Attempted To Solve the Problem. Point Out Disadvantages and Weaknesses in Prior Art. Include Literature References where Available.

    (3) Description of Invention Including a Specific Embodiment. Point Out Important Features and Points Believed To Be Novel. State Advantages of Invention and Sacrifices, If Any, Made To Achieve These Advantages. Describe Any Experiments Conducted and Results of Those Experiments.

    (4) Is the Concept of the Invention Applicable to Other Problems and Fields of Interest? If So, What Are They and How Would the Principles of the Invention Be Used?

    (5) The Inventor(s) **and** Witnesses Should Sign and Date **Each Page** of the Attached Disclosure.

The Invention Described by the Attached Patent Disclosure which Comprises__________Pages Is Submitted Pursuant to My Employment Agreement with Texas Instruments Incorporated.

Sign Full Name(s). (1)__________ Date: July 23 1965
(2)__________ Date:
(3)__________ Date:

☐ This invention was first explained to me by the inventor(s) on __________ 19___, and understood by me; and/or

☐ The attached disclosure was read and understood by me on July 23, 1965, 19___

7-23-65
Signature of Witness, — Date

☒ This invention was first explained to me by the inventor(s) on April, 1965 19___, and understood by me; and/or

☐ The attached disclosure was read and understood by me on______ 19___

Edward B. [illegible] 7/26/65
Signature of Witness — Date

F-5

DEPTH CONTROLLER

This invention consists of a means of controlling the depth of a towed streamer submerged below the water surface.

Streamers constructed, such as to be approximately neutrally buoyant and containing sensing elements for receiving acoustic energy propogated through the water, are widely used in seismic exploration for oil and other purposes.

REFERENCE PATENT: 2,465,696
2,729,300

It has been found, by experience, that if the front end of the streamer is controlled by means shown in the above patents and if the streamer is carefully adjusted as to weight and size so as to be nearly neutral buoyancy, that the streamer will maintain a sufficiently near constant depth through out its length, in most cases - if it is no longer than approximately 2,400 feet long. It has also been found, by experience, that if the streamer is as long as 8,000 feet, that it is a practical impossibility to maintain a reasonability constant depth through out its length by weight and buoyancy adjustments. A streamer cannot be made exactly buoyancy for the following reasons:

a. The streamers are oil filled and temperature variations cause changes in the density of the oil; and thus, a change in buoyancy.

b. Changes in the salinity of the sea water, from one location to another, causes variations in the buoyancy. This is an especially large effect off shore from the mouths of rivers where the fresh water from the rivers dilutes the sea water in "streams" or "streaks".

c. The oil is more compressible than water. Increased depths cause increased density relative to water. Decreased depth causes decreased density relative to water. Thus, the buoyancy adjustment is unstable.

It is desirable, from the standpoint of the seismic signals processing and interpretation, to use streamers as long as 8,000 feet or more.

INVENTOR DATE
July 23 1965

WITNESS DATE

WITNESS DATE
7/21/[illegible]

F-6

This device, such as shown in Figure 1, has been built and tested. This device, when under tow underwater, will closely maintain a constant 30 foot depth, even when attached to a load (streamer) which is either heavier or lighter than water. The amount of load it will control is, of course, a function of the towing speed. For example, the controller, shown in Figure 1, at 4 MPH towing speed will control forces as high as 100 pounds excess weight or excess buoyancy. This particular controller has a wing chord of 39 inches and a wing span of 36 inches.

EXPLANATION OF OPERATION

The Pressure Actuator construction is shown on Drawing SK-BB-P38-101. This pressure actuator senses the depth of the water and also furnishes the forces needed to position the elevator.

The pressure actuator consists of a barrel and cover ① and ② , a piston assembly of parts ④ , ③ , ⑤ , ⑥ , ⑫ and bellows ⑪ A spring ⑩ exerts force on the piston tending to keep the piston assembly in contact with the cover ② . The drawing shows the piston in mid-position, as it is when it is at design depth. The force of the spring is balanced by the external water pressure acting on the piston area. At lesser depths, the spring forces the piston in the up ward direction. At greater depths, the water pressure forces the piston down ward compressing the spring further. Through the linkage ⑨ , ⑲ , ⑯ , ⑧ , the motion is transferred to the elevator control rod (Figure 1); and thus, to rotate the elevator.

The spring ⑩ is so designed that it must be compressed upon assembly into the pressure actuator assembly. Thus at the water surface, the spring is holding the piston against the cover ② . Movement of the piston does not occur until there is sufficient pressure (depth) to over come this initial spring force. Thus, piston motion is not proportional to depth. The action is shown in graph at lower left of Figure 1.

At the surface, the elevator has a 15° angle to cause lift of the tail; and thus, forces the wing to a dive angle. As the device is towed, it dives. Due to the precompression of the spring in the pressure actuator, no change in elevator angle will occur until a depth of 26 feet is reached. As the device continues to dive, the increased water pressure causes a reduction of elevator angle until at 30 foot depth the pressure actuator

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INVENTOR DATE July 23 1965

WITNESS July 23, 1965 DATE

Edwin B. Hertzel 7/26/65
WITNESS DATE

F-7

piston is in mid-position, the elevator angle is at zero degrees, the wing is at zero angle to the water flow and there is no more diving force.

If the streamer is heavier than neutrally buoyant, the controller will be forced to a depth greater than 30 feet, the pressure actuator will cause the elevator to move to an angle causing depression of the tail and the wing into a climbing angle. It will, thus, automatically arrive at a climbing angle (or diving angle) such as to counter balance the force acting upon it.

This means of turning the elevator through the full range of 30° over a depth change of eight feet results in control of depth close to 30 feet, even though the streamer is considerably heavy or light.

While the explanations are confined to a device for controlling a streamer at 30 foot depth, the device can be made to control at any desired depth by selecting a suitable spring for the pressure actuator. Also, the device can be used for controlling the towed depth of other equipments such as sonar transducers, sensor for measuring temperatures, salinity, light intensity, etc.

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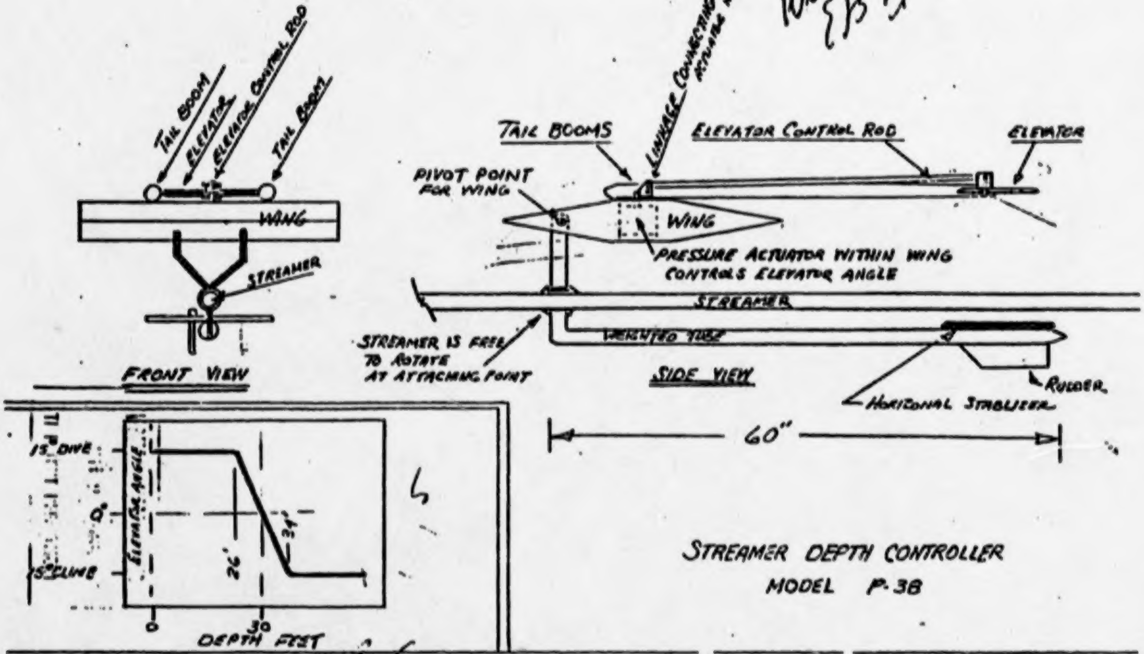
INVENTOR DATE

Joseph R. Reid July 23, 1965
WITNESS DATE

Elgin B. Weitzel 7/26/65
WITNESS DATE

WING IS BUOYANT, PARTS BELOW STREAM ARE WEIGHTED, THUS MAINTAINING WING HORIZONTAL. ENTIRE DEVICE IS SLIGHTLY BUOYANT.

Witnessed E B Heitzel 7-26-65


TAIL BOOM
ELEVATOR
ELEVATOR CONTROL ROD
TAIL BOOM
WING
STREAMER
FRONT VIEW
TAIL BOOMS
LINKAGE CONNECTING PRESSURE ACTUATOR WITH ELEVATOR CONTROL ROD
ELEVATOR CONTROL ROD
ELEVATOR
PIVOT POINT FOR WING
WING
PRESSURE ACTUATOR WITHIN WING CONTROLS ELEVATOR ANGLE
STREAMER
WEIGHTED TUBE
STREAMER IS FREE TO ROTATE AT ATTACHING POINT
SIDE VIEW
RUDDER
HORIZONAL STABILIZER
60"
15° DIVE
0°
15° CLIMB
ELEVATOR ANGLE
26'
34'
0
30
DEPTH FEET

STREAMER DEPTH CONTROLLER
MODEL P-38

Alfred Nillis Baker
July 23 1965

FIG 1

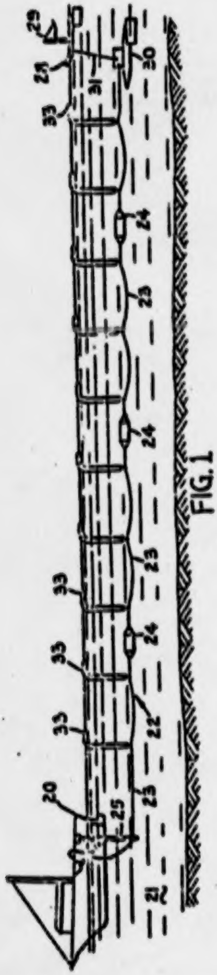
APPENDIX G

G-1

Aug. 19, 1952 A. C. REID 2,607,842

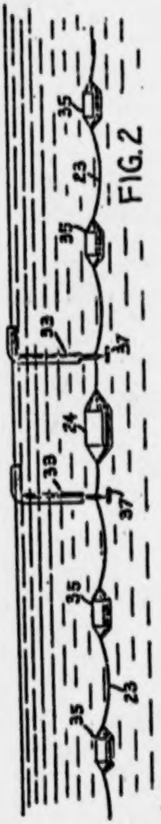
MARINE SEISMOMETER SPREAD

Filed March 2, 1949 2 SHEETS—SHEET 1



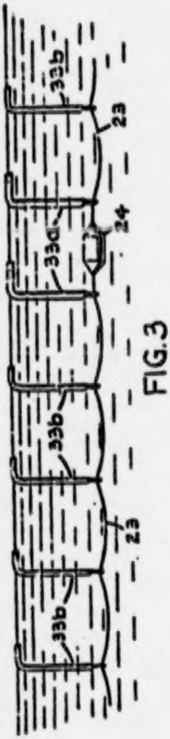
29
25
33
31
30
24
23
24
23
33
33
24
33
22
20
25
23
21

FIG.1



35
23
35
33
37
24
33
37
35
23
35

FIG.2



33b
23
33a
24
33b
23
33b

FIG.3

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G-2

Aug. 19, 1952 A. C. REID 2,607,842

MARINE SEISMOMETER SPREAD

Filed March 2, 1949 2 SHEETS—SHEET 2

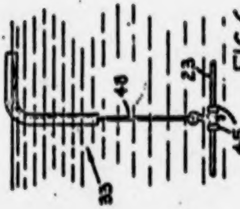

FIG. 6

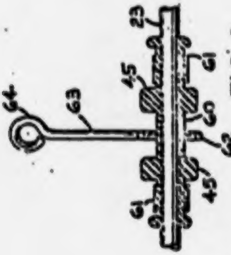
64
63
23
45
61
60
62
45
61

FIG. 9

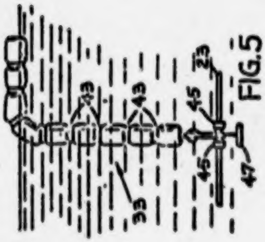
43
43
33
45
23
45
47

FIG. 5

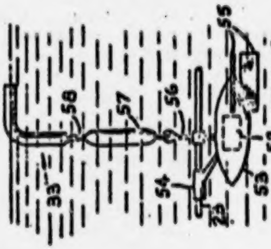
33
58
57
56
54
25
52
53
55

FIG. 8

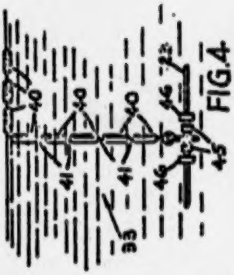
40
40
40
41
41
33
46
46
23
45

FIG. 4

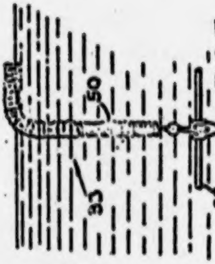

FIG. 7

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Patented Aug. 19, 1952 [illegible]

UNITED STATES PATENT OFFICE

2,607,842

MARINE SEISMOMETER SPREAD

Albert C. Reid, Tulsa, Okla., assignor to Stanolind Oil and Gas Company, Tulsa, Okla., a corporation of Delaware

Application March 2, 1949, Serial No. 79,234

10 Claims. (Cl. 177—352)

This invention relates to geophysical surveying and is directed particularly to prospecting by the seismic method over water-covered areas such as in the Gulf of Mexico.

Geophysical surveying using artificially-created seismic waves has been extensively and successfully used on land for a number of years, but it is only comparatively recently that the method has been applied to off-shore explorations for oil and gas, particularly in the Gulf of Mexico. In the earliest applications of the seismic method to marine areas, the shots and detectors were individually placed on or under the marine floor in much the same manner as in prospecting on land. The results obtained were generally similar to those obtained on land prospects.

With the improvement and adaptation of specific techniques and instruments for this marine work, the speed of prospecting by this method has increased so markedly over what was previously possible either on land or water that, as a result, more than the normal ratio of geophysical effort in marine prospecting has been concentrated on the seismic method as compared with the magnetic and gravimetric methods, for example.

Both now and in the past one of the difficult problems connected with this method has been the proper handling of the seismometers used for detecting the seismic waves. Placing the seismometers at known locations in a spread on the marine floor as in land prospecting proved even more laborious and time-consuming than on land. Towing a spread of seismometers connected together by a conductor and tension cable along the marine floor or supported by floats behind the recording vessel from one location to another, and shooting either with the seismometers on the marine floor or supported from the floats have resulted in marked increases in the speed of carrying out the geophysical surveys. However, dragging of the seismometer spread along the sea bottom presents disadvantages in the obvious hazards both to the equipment and to the marine life and to installations located on the marine floor. Employing seismometers at or near the surface and supported by floats of conventional design results in the picking up of a great deal of noise, even under favorable conditions of low wind velocity and relatively smooth water surface. Even in calm seas, the noise picked up by near-surface seismometers is such as to mask most of the desired weak reflections, while on windy days and when the water surface is rough, the noise may be so strong as to override all reflections and make prospecting impossible. As a matter of fact, there are some seasons of the year in the Gulf of Mexico when the noise conditions from the water surface have been so troublesome that prospecting operations were possible only a small fraction of the time. The resultant delays while the crews and equipment are held in readiness for favorable working conditions add very greatly to the expense of the operation.

It is, accordingly, a primary object of my invention to provide a marine seismometer assembly which gives a greatly improved signal-to-noise ratio, permitting the detection of deeper and weaker desired seismic reflection signals. Another object is to provide a seismometer spread assembly for marine prospecting in which the depth of the seismometers is automatically controlled to bring them to the most effective depth for signal reception. A further object is to provide a marine seismometer spread capable of operation under adverse weather or water conditions to obtain good geophysical data which could not hitherto be obtained under such conditions. Still another object is to provide a towable marine seismometer spread in which the depth of submergence of the seismometers is automatically float-controlled from the water surface, but in a manner which minimizes the transmission of noise signals from the water surface to the seismometers. A still further object is to provide a towable marine seismometer spread which creates a relatively small drag on the towing vessel, thereby reducing the travel time between shot points and increasing the speed of the prospecting operation. Still another and further object is to provide for a marine seismometer spread, a type of depth-controlling float which automatically regulates the seismometer depth and compensates for changes in buoyancy while effectively filtering out water-surface noises. Another and still further object of my invention is to provide a marine seismometer spread suitable for use in areas where the depth of water is too great to permit prospecting by methods which require placing the seismometers on the marine floor. Other and further objects, uses, and advantages of the invention will become apparent as the description proceeds.

From observations made under a variety of conditions, it has now been found that the range of depths in water where seismometers may be placed for the most efficient operation is relatively narrow. Due to the greatly different seismic-wave transmission properties of air and water, seismic waves traveling upward from the earth below the water through the water to its surface are almost totally reflected there. As a result, there is a strong probability of interference between succeeding waves in a train of seismic waves at a depth in the water which is one-quarter of the seismic wave length in that medium. To avoid this possible interference, which changes the "character" or appearance of the detected waves, it is therefore desirable to locate the seismometers as close as possible to the water surface. It is at this surface that the displacements are a maximum and hence the possible interference is a minimum.

As was briefly indicated above, it has been found that the level of the noise within the seismic wave band is a maximum at the water surface, and further that this noise drops off very sharply with depth. There is accordingly a narrow range of depths for optimum seismometer operation. The upper limit of this range is immediately below the zone of surface water noise and is determined by the place where the noise level drops to a satisfactorily low value. The lower limit of the range is the depth at which interference effects become pronounced for waves of interest in the seismic band and is in practice somewhat less than the quarter-wave-length depth, which is where the interference becomes a maximum. Partial interference is noticeable at shallower depths. This range appears to be between 5 and 15 feet, with the preferred depth of operation being about 10 feet. Above this range the noise level is generally appreciable, while below it interference is observed for waves of interest in the seismic band. In areas where strong reflections are found and on days when the water surface is unusually calm, operations may be conducted above 5 feet but still below the water surface, and the resulting noise is not too great to be tolerated.

The foregoing enumerated and other objects of my invention are accomplished by a marine seismometer spread which is designed to be towed through the water at some distance below the water surface and to submerge automatically to the desired operating depth at a shooting location. This depth control is achieved by a particular design of float for suspending the negatively buoyant cable and seismometers. The preferred floats are flexible, elongated, tubular members of a considerable length, generally of the same order of magnitude as the desired depth of seismometer submergence, which members are attached by one end to the seismometer or the cable, and have the other end extending to the water surface. Being flexible, any excess length of the float beyond that required to support the attached portion of the spread does not project appreciably above the water surface, but lies along this surface parallel to it. The float being of small cross-sectional area, wave motions at the water surface have a minimum effect on varying the total buoyancy of the submerged portion of the float, and thus the depth of submergence of the seismometer or cable is not varied in any appreciable degree by surface waves. Variations in the buoyancy of the cable or seismometers themselves are compensated automatically by small changes in the length of the submerged portion of the float, which, in all cases, is arranged to be less than the total length of the float.

As the float is constructed of material which is highly flexible and compliant, noise which is generated by motions of the water relative to a

rigid float is absent. Other water-surface noises are attenuated by the resilience of the float material which damps out, rather than transmits, vibrations impressed on it.

This will be better understood by reference to the accompanying drawings, forming a part of this application and illustrating typical embodiments of my invention, in which drawings like numerals are applied to the same or corresponding parts in the different figures. In these drawings,

Figure 1 is a cross-section of a body of water through which a marine seismometer spread, constructed in accordance with the invention, is being towed by a vessel and is shown in a position suitable for making a record;

Figure 2 is a cross-section of water showing an embodiment of the invention used for depth control as distinguished from support for the spread;

Figure 3 is a similar cross-section showing a modification of the spread of Figure 1;

Figures 4, 5, 6, and 7 are cross-sections of water showing various advantageous embodiments of the float of my invention;

Figure 8 shows a modification of a seismometer assembly, consisting of a separate seismometer-supporting float and the depth-controlling float of the invention; and

Figure 9 is a cross-section showing a means of coupling the float of the invention to the spread cable.

Referring now to these drawings in detail and to Figure 1 in particular, a vessel 20 is shown proceeding through a body of water 21, towing a spread 22 constructed in accordance with my invention. Spread 22 is made up of a tension and conductor cable 23, attached to vessel 20 and having both a considerable tensile strength for connecting together and towing the various components, and a plurality of insulated electrical conductors for the seismometer signal leads. Spaced at any desired intervals along the length of cable 23 are a plurality of streamlined, detector-containing units 24, which may be more or less buoyant in the water 21. The detector housed within each unit 24 is appropriately connected by a waterproof splice and insulated lead to the conductors within the cable 23. Towing force is preferably applied from the vessel 20 to the spread 22 by connection to the vessel 20 at the desired operating depth for the detectors in units 24, such as by means of the spar 25 which projects down into water 21 to the desired depth, and to which the forward end of cable 23 is attached. While being towed, and during forward motion through the water, spread 22 is maintained in tension, and also to some extent when it is slowed down or stopped for recording, by an assembly connected to the trailing end at cable 23 consisting of a float 28, which may carry a flag 29, and a sinker 30 coupled to float 28 by a connecting lead 31. The length of lead 31 is adjusted so that this assembly maintains the trailing end of cable 23 at the desired operating depth in a manner similar to spar 25 on the forward end. Flag 29 which may be seen by an observer on the vessel 20 is useful for indicating the direction of the spread, particularly in the presence of cross-currents.

In accordance with my invention, spread 22 is supported at points intermediate the forward and trailing ends of cable 23 by a plurality of spaced buoyant, elongated tubular floats 33, attached by one end to the cable 23, and of a length sufficient to extend to the surface of water 21 and some distance beyond. These floats 33 are preferably quite flexible so that the top end of each float does not project appreciably above the surface of water 21, but bends over and lies along parallel to it, as shown in the drawings. The spacing of floats 33 along cable 23, and their relative buoyancies, are preferably so adjusted that a portion of each float 33 remains at the surface, and the cable 23 or the seismometer-containing unit 24 is then automatically balanced as to buoyancy by the submerged portion of each float 33, with the detector units 24 at the desired depth for operation. Stated otherwise, the negative buoyancy supported by each float is arranged to be less than its maximum positive buoyancy, so that there is always a portion of the float at the water surface to function as a reserve buoyancy. These floats 33 act as automatic depth controls in that changes in buoyancy of any portion of the spread are automatically compensated by changes in length of the submerged portion of the float. The introduction of noise into the detector signals is prevented by at least three factors: (1) the top end of the float does not project appreciably above the water surface where it can be affected by winds; (2) the highly resilient material such as rubber or plastic film, of which the float is preferably constructed, is a poor conductor of such vibrations as may be impressed on the top end of the float; and (3) the slow change in buoyancy due to the small cross-sectional area of the tube as waves move past the surface end of the float, even if it is transmitted to the seismometer, is an impulse far below the frequency response of the recording equipment, as compared to the high-frequency jerks from a horizontal float concentrated at the surface. Furthermore, this comparatively small cross-sectional area of these floats renders the entire spread 22 more or less streamlined so that it is easily towed through the water by the vessel 20.

In Figure 1, the entire spread is supported by the floats 33 extending to the water surface. In Figure 2 is a modification of this invention in which the elongated, flexible, buoyant floats 33 are used not for the major support of the spread, but merely to control the depth of submergence of the seismometer-containing units 24. In this modification, the chief support of the negatively buoyant cable 23 and seismometers in units 24, is provided by attached buoyant cable floats 35, which are preferably streamlined and extend along the length of the cable itself, and by making the unit 24 itself buoyant in the water 21. The buoyancy of floats 35 and of the unit 24 is adjusted either by spacing or by the addition of small weights, to bring each portion of the whole spread consisting of the cable 23 and the seismometers of units 24 to an approximately neutral value of buoyancy in the water. Automatic and accurate control of the depth of the seismometer unit 24 is then provided by one or more of the buoyant floats 33 connected to spread 22, preferably at a short lateral distance from each seismometer unit 24, the excess buoyancy of the submerged portions of the floats 33 at the desired operating depth for the unit 24 being countered by attaching weights 37 at the lower ends of these floats. The tension in cable 23, maintained by the end assembly consisting of float 28 and sinker 30, or due to the forward motion of the spread through the water, with this assembly omitted if desired, is then effective in cooperation with the depth-control floats 33 operating at definite points of the cable 23 to maintain the seismometer units 24 at the optimum operating depth.

In Figure 3 is shown a particularly advantageous embodiment of the spread of Figure 1 in which the cable 23 and seismometer units 24 are entirely supported by the elongated floats 33. In this figure, the particular floats 33a connected to the cable 23 and chiefly responsible for the depth control of the seismometer units 24 are of distinctly larger cross-sectional area than the floats 33b, spaced along the cable 23 itself, between the locations of seismometer units 24. By thus making the buoyancy per-unit-length of the floats 33 different depending on the amount of the support for the spread 22 required of them, the spacing of these floats along the cable may be maintained reasonably uniform. It is preferred that the floats 33b support cable 23 at points spaced from 15 to 50 feet apart—for example, about 25 feet. Unsupported sections of cable 23 longer than 50 feet or so are undesirable. The point of attachment of the floats 33a to the cable 23 on either side of the seismometer unit 24 is spaced from that unit by distances of from one to 10 feet—preferably about 3 feet. This provides a somewhat greater length of path for attenuating noise vibrations impressed on the top ends of the floats 33a. Although the seismometer unit 24 of Figure 3 may be completely non-buoyant, it is preferred, however, that it possess a substantial buoyancy in the water so that its entire support is not provided by the floats 33a. It is preferred also to adjust the buoyancy per unit length of the floats 33b and their spacing along the cable so that the desired spacing interval can be maintained reasonably uniform without the addition of many balancing weights 37.

It will be noted that when float 33 is in the form of a single elongated flexible tube, it will be collapsed by the water pressure at its lower end, if the inflation pressure is less than the hydrostatic pressure at that depth. As a matter of fact, by permitting more or less of the float 33 to collapse under the pressure of the water at its lower end, a convenient method of adjusting the buoyancy of these floats is provided, in that it is only necessary to vary the inflation pressure to change the buoyancy of the submerged portion of the float. In some cases, however, the required inflation pressure will render the upper portion of the float more rigid than is desirable, which may interfere with its tendency to lie flat along the water surface. One way of overcoming this is to fix a small weight to the top end of the float sufficient to make it bend over and lie flat along the water surface. Another way to achieve the same result is to construct float 38 of coupled, individually-inflated sections, at least two and preferably several in number, as shown in Figure 4. With such an arrangement it is impossible for the water pressure at the lower end of the float to cause complete collapse of any one of the individual sections 40, held together by the highly flexible cords 41. The individual sections 40 may be all inflated to the same pressure, or those submerged to greater depths in the water may be inflated to higher pressures than those at the surface, so that the latter are more flexible.

A similar arrangement is shown in Figure 5, in which the float 33 comprises a single elongated tube, which is effectively divided into at least two, and preferably several, individual sections by internal discs around which the outside tubular member of the float 33 is held by wrappings or clamps 43 thus forming a series of isolated pock-

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ets. In this case, also, it is possible to increase the flexibility of the upper portion of the float 33 by having lower inflation pressures for the tube. Any excess buoyancy of the submerged portion of the float 33 when the cable 23 is at the desired depth can be balanced out by small lead straps 46 wrapped around cable 23 close to the point of attachment of the float to the cable (Figure 4) or by a single weight 47 attached to the lower end of float 33 itself, as shown in Figure 5. The float 33 in these two figures is preferably loosely attached to the cable 23 to permit rotation or twisting of the cable without wrapping the float or its connecting lead around it. A pair of shoulders 45 fixed to the cable 23 prevent the point of attachment of the float 33 from shifting along the cable.

In Figure 6 is shown another way, besides spacing and variable inflation pressures, to have simultaneously the proper buoyancy for the float 33 and the proper depth of submergence of the cable 23. When the length of float 33 required to support the attached negatively buoyant portion of cable 23 is considerably less than the desired depth of submergence of the cable, it is only necessary to insert between the lower end of float 33 and the point of attachment to cable 23 a cord 48 of the proper length to let the cable 23 be at the desired depth. This cord can be either made of fibers and have a fixed length, or resilient and of a length varying with the applied tension to attenuate noise vibrations further.

In Figure 7 is another embodiment for the float 33 which has the advantage of high flexibility with low inflation pressure and at the same time avoids the collapsing of the lower end of the float by the pressure of the water. The float 33 in Figure 7, or at least the lower end of the submerged portion of it, is internally supported by a highly flexible helical wire spring 50 which is radially rigid but highly extensible lengthwise. It thus supports the lower end of the tubing of float 33 against collapse by external pressure without interfering with free flexing of the tube at the water surface.

In Figure 8 is shown an embodiment of a marine seismometer employing the depth-controlling float of the invention in a somewhat different manner from those in the preceding figures. The negatively buoyant seismometer 52 is surrounded by a small streamlining housing 53 and electrically connected to the conductors in cable 23 by the waterproof splice 54. Vanes 55 on housing 53 improve its towing qualities through the water, while a rigid rod 56 connects the housing 53 and the cable 23 to a main supporting float 57. This float 57 is preferably a resilient, inflatable unit of substantially fixed buoyancy designed to support the major portion of the negative buoyancy of the seismometer 52, the housing 53, and the cable 23. Rod 56 is of a length such that the supporting moment of float 57 holds the seismometer in an upright position and counteracts any tendency of the cable 23 to twist. The remainder of the required support is provided by the varying buoyancy of the elongated flexible tubular depth-controlling float 33 attached either to the seismometer itself or to the upper end of supporting float 57 by a resilient connection 58. This assembly is one having good towing properties in the water 21, and it simultaneously obviates the need for gimbal-suspension of the seismometer 52.

A simple and effective device for connecting the cable 23 and the float 33 while permitting free

rotation of the cable is shown in Figure 9. A non-metallic, resilient cylindrical sleeve 60, carrying the two shoulders 45 and provided with extensions beyond these shoulders, surrounds the cable 23 and is held from slipping longitudinally along the cable by the clamps or wire wrappings 61. Surrounding the central portion of sleeve 60 between the shoulders 45 is a metallic ring 62 fixed to or part of a rod 63 extending radially from the cable and terminating in a ring 64 to which the end of the float 33 is attached. Ring 62 fits loosely around the sleeve 60, permitting free rotation of cable 23, and the rod 62 prevents any possibility of the connecting cord to the float 33 being wrapped around cable 23. By making sleeve 60 of rubber, its contact with metal ring 62 is effectively lubricated by the water, and relative rotations of the ring and sleeve do not generate noise in the seismic-wave band. Preferably rings 62 and 64 are formed on the ends of the rod 63 by bending it into the proper shapes.

While I have thus described my invention in terms of the foregoing specific embodiments, numerous useful modifications will occur to those skilled in the art. For example, when the expression "attached at one end" is employed herein with regard to the manner of attaching the elongated float to the spread, "substantially at one end" is meant. Thus an elongated tube could be attached by its center to the spread cable, and the result would in effect be two elongated floats in parallel, each attached by one end to the cable. Likewise, although tubular floats of substantially uniform diameter have been illustrated, a tube having a varying diameter along its length might prove equally useful in many instances. The scope of the invention therefore should not be considered as limited to the exact details set forth, but is to be ascertained from the scope of the appended claims.

I claim:

1. A marine seismometer assembly adapted for towing by a vessel through a body of water comprising a tension and conductor cable, a plurality of seismometers spaced along said cable and connected to conductors therein, a plurality of spaced elongated flexible tubular floats, and means for attaching each of said floats to said cable, including a resilient non-metallic sleeve surrounding said cable and having a pair of spaced annular shoulders, means for fastening said sleeve to said cable, and a rigid metal rod having one end formed into a ring loosely surrounding said sleeve between said shoulders and of smaller diameter than said shoulders, the other end of said rod being attached to said float.

2. A marine seismic-surveying assembly adapted for towing by a vessel through a body of water comprising a spread consisting of a tension and conductor cable and a plurality of seismic-wave detectors spaced along said cable and connected to conductors therein, and a plurality of spaced, buoyant floats attached to said spread and at least in part supporting it below the surface of the water, each of said floats comprising an elongated, flexible, buoyant member having, when in use, two portions, one portion extending generally vertically through the water below the surface and providing positive buoyancy, and the other portion extending generally horizontally along the water surface, the flexibility of said member being so great that the surface portion is not self-supporting vertically by the below-surface portion but collapses to a horizontal position along

the water surface, and the positive buoyancy exerted by said float being normally equal to the negative buoyancy of the adjacent portion of said spread, but variably greater or less than normal as the relative amounts of said two portions are varied by wave motions.

3. A marine seismic-surveying assembly as in claim 2 in which said elongated, flexible, buoyant member is formed of a plurality of individual, buoyant sections connected together.

4. A marine seismic-surveying assembly according to claim 2 in which there is a connecting means between each of said floats and said spread comprising a connecting cord extending from the end of said member to said spread at a desired depth in the water, the length of said connecting cord being a substantial portion of the depth of submergence of said spread.

5. A marine seismic-surveying assembly according to claim 2 in which said elongated, flexible member is tubular in form, and including flexible, radially rigid means supporting the walls of said tubular member to prevent its being collapsed by water pressure.

6. A marine seismic-surveying assembly adapted for towing by a vessel through a body of water comprising a spread consisting of a tension and conductor cable and a plurality of seismic-wave detectors spaced along said cable and connected to conductors therein, a plurality of spaced floats supporting said cable and detectors, the buoyancy of said floats, detectors, and cable being adjusted to give said spread a substantially neutral density in the water except near each of said detectors where the buoyancy is negative, at least one depth-controlling float attached to said spread near each of said detectors, said depth-controlling float comprising an elongated, flexible, buoyant member having, when in use, two portions, one portion extending generally vertically through the water below the surface and providing positive buoyancy to balance said negative buoyancy, and the other portion extending generally horizontally along the water surface, the flexibility of said member being so great that the surface portion is not self-supporting vertically by the below-surface portion but collapses to a horizontal position along the water surface, and the positive buoyancy exerted by said float being normally equal to the negative buoyancy of the adjacent detector and cable, but variably greater or less than normal as the relative amounts of said two portions are varied by wave motions.

7. A marine seismic-surveying assembly as in claim 6 in which there are two of said depth-controlling floats for each of said detectors, one of said two floats being attached to said cable on each side of and a short lateral distance away from the detector.

8. A marine seismometer assembly adapted for towing by a vessel through a body of water comprising a spread consisting of a tension and conductor cable and a plurality of seismometers spaced along said cable and connected to conductors therein, and a plurality of spaced supporting floats attached to said spread, the spacing of said floats being such that the negative buoyancy of the portion of said spread supported by each float is less than the maximum positive buoyancy each float is capable of exerting, whereby at least a part of said float remains at the water surface, each of said floats comprising an elongated, flexible, tubular, buoyant member having, when in use, two portions, one portion extending generally vertically through the water at the surface and providing the positive buoyancy, and the other portion extending generally horizontally along the water surface, the flexibility of said member being so great that the surface portion is not self-supporting vertically by the below-surface portion but collapses to a horizontal position along the water surface, and the positive buoyancy exerted by said float being normally equal to the negative buoyancy of the adjacent portion of said spread, but variably greater or less than normal as the relative amounts of said two portions are varied by wave motions.

9. A marine seismometer assembly adapted for towing by a vessel through a body of water comprising a spread consisting of a tension and conductor cable and a plurality of seismometers spaced along and connected to conductors in said cable, a plurality of floats supporting said spread below the water surface, each of said floats comprising an elongated, flexible, buoyant member having, when in use, two portions and including means for attaching one end of said member to said spread, one portion of said member extending generally vertically through the water below the surface and providing positive buoyancy, and the other portion extending generally horizontally along the water surface, the flexibility of said member being so great that the surface portion is not self-supporting vertically by the below-surface portion but collapses to a horizontal position along the water surface, the positive buoyancy exerted by said float being normally equal to the negative buoyancy of the adjacent portion of said spread, but variably greater or less than normal as the relative amounts of said two portions are varied by wave motions, and the combined length of the submerged portion of said member and said attaching means being between 5 and 15 and preferably about 10 feet.

10. A marine seismometer assembly adapted for towing by a vessel through a body of water comprising a tension and conductor cable, a plurality of negatively buoyant seismometers spaced along said cable, buoyant means supporting said cable below the water surface, insulated electrical leads connecting each of said seismometers to conductors in said cable, a pair of floats attached to and supporting each of said seismometers at a desired operating depth in the water, one of said floats having a substantially fixed positive buoyancy and being completely submerged when said seismometer is at said desired depth, and the other of said floats being an elongated, flexible, tubular, buoyant member having, when in use, two portions, one portion extending generally vertically through the water below the surface and providing additional positive buoyancy, and the other portion extending generally horizontally along the water surface, the flexibility of said member being so great that the surface portion is not self-supporting vertically by the below-surface portion but collapses to a horizontal position along the water surface, and the positive buoyancy exerted by said float being normally equal to the residual negative buoyancy of the attached seismometer, but variably greater or less than normal as the relative amounts of said two portions of said member are varied by wave motions.

ALBERT C. REID.

(References on following page)

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The following references are of record in the file of this patent:

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Number	Name	Date
1,470,733	Hayes	Oct. 16, 1923
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2,570,707	Parr	Oct. 9, 1951

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Popular Mechanics, May 1941, pp. 728, 729 and 114A.

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FILED
MAY 12 1981
ALEXANDER L. STEVAS,
CLERK

No. 80-2037

IN THE

Supreme Court of the United States

OCTOBER TERM, 1980

JIMMY R. COLE, d/b/a JIM R. COLE & ASSOCIATES and COLE DEVELOPMENT COMPANY, INC.,
Petitioners,

versus

CONTINENTAL OIL COMPANY,
Respondent.

PETITIONERS' SUBSTITUTION APPENDICES A-C

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Petitioners' Substitution Appendix B: Memorandum Opinion of United States District Court for the Southern District of Texas, Houston Division, dated March 8, 1978. . . . . B-1

Petitioners' Substitution Appendix C: Rule 35, Federal Rules of Appellate Procedure; Local Fifth Circuit Rule 12. . . . . C-1

PETITIONERS' SUBSTITUTION APPENDIX A

CONTINENTAL OIL COMPANY,
Plaintiff-Appellant, Cross-Appellee,

v.

Jimmy R. COLE, d/b/a Jim R. Cole & Associates and
Cole Development Co., Inc.,
Defendants-Appellees, Cross-Appellants.

No. 78-1961

UNITED STATES COURT OF APPEALS
Fifth Circuit

Jan. 12, 1981

Rehearing and Rehearing En Banc
Denied Feb. 12, 1981

Plaintiff appealed from a determination of the United States District Court for the Southern District of Texas, at Houston, Robert O'Conor, Jr., J., that its patent for a seismic cable depth-controlling paravane was not infringed by a device patented by defendant. Defendant cross appealed, challenging the validity of plaintiff's patent. The Court of Appeals, Politz, Circuit Judge, held that: (1) plaintiff's patent No. 3,375,800 for a seismic cable depth-controlling paravane was valid; the paravane was neither anticipated by the prior art nor were the claims obvious to one ordinarily skilled in the art; (2) the creative process existing prior to issuance of plaintiff's patent was in an embryonic stage, and it would be manifestly unjust to characterize said patent as anything other than innovatively different and not readily obvious to a person of ordinary skill in the field of marine seismology; (3) defendant's accused device infringed the range of equivalents of plaintiff's patent; and (4) the doctrine of file wrapper estoppel was inapplicable.

Reversed, rendered and remanded.

C. Frederick Levdig, John W. Kozak, H. Michael Hartmann, Chicago, Ill., Frank B. Pugsley, G. Bryon Jamison, Houston, Tex., for plaintiff-appellant, cross-appellee.

Pravel, Wilson & Gambrell, Albert B. Kimball, Jr., B. R. Pravel, Houston, Tex., for defendants-appellees, cross-appellants.

Appeals from the United States District Court for the Southern District of Texas.

Before RUBIN and POLITZ, Circuit Judges, and SMITH,* United States District Judge.

POLITZ, Circuit Judge:

Continental Oil Company (Conoco) appeals the determination by the trial court that its patent for a seismic cable depth-controlling paravane is not infringed by a device patented by Jimmy R. Cole. Cole cross-appeals, challenging the validity of Conoco's patent. We disagree with the trial judge and conclude that Cole's device infringes, being equivalent in function and operation to Conoco's paravane. We also conclude that Conoco's patent is valid. We therefore reverse the decision of the trial judge, render judgment in favor of Conoco and remand for further proceedings.

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* District Judge of the Northern District of Mississippi, sitting by designation.

[1-3] The issues posited to us can be resolved by applying well-established principles which have been stated and re-stated and, in the main, need only be capsulated. The sine qua non of appellate review of patent litigation is the notion that validity and interpretation are legal questions based upon factual inquiries. When confronted with pure questions of law, we are free to examine the district judge's answers and correct any error or oversight. In contrast, factual questions resolved by the trial court warrant deference and reversal is mandated only if the findings are clearly erroneous. Fed. R. Civ. P. 52(a). Although infringement normally is a fact question, legal questions of construction can become so intertwined that the clearly erroneous standard of review applicable to a pure fact finding must yield. The appeal we now decide falls into this latter category.

[4, 5] One form of infringement occurs when an accused device incorporates a teaching literally read. An infringement also occurs when a device appropriates a prior invention by incorporating its innovative concept and, albeit with some modification and change, performs substantially the same function in substantially the same way to achieve substantially the same result. The "doctrine of equivalents" shields the inventor from such abuse.

[6-8] The determination of equivalency involves an examination of the scope of prior art, the essence or "heart" of the invention disclosed and the step forward the invention offers. A pioneer or generic patent which opens a new path is entitled to broader protection than a patent which merely improves upon that which is already

known. The ambit of equivalency is also limited by the claims as made, amended or surrendered in the process which make up the "file wrapper" and grounds the defense of "file wrapper estoppel."

These principles were essentially noted by us in our recent decision in *Weidman Metal Masters v. Glass Master Corp.,* 623 F.2d 1024 (5th Cir. 1980), and cases cited therein, particularly *Studiengesellschaft Kohle v. Eastman Kodak Co.,* 616 F.2d 1315 (5th Cir. 1980).

[9] In the case *sub judice* we are not favored with "findings . . . sufficiently detailed to give us a clear understanding of the analytical process by which ultimate findings were reached and to assure us that the trial court took care in ascertaining the facts." *Golf City, Inc. v. Wilson Sporting Goods, Co., Inc.,* 555 F.2d 426, 433 (5th Cir. 1977). Instead, the trial court's findings are in the main conclusory. In this situation we routinely would remand for more specific findings. However, "[t]his failure is merely a hindrance and not a fatal error." *Whitley v. Road Corp.,* 624 F.2d 698, 700 (5th Cir. 1980). "Where the evidence is such that without weighing the credibility of the witnesses there can be but one reasonable conclusion as to the result, the case can be taken from the factfinding body." *Waldon, Inc. v. Alexander Manufacturing Company,* 423 F.2d 91, 93 n.3 (5th Cir. 1970).

The record is replete with evidence fully establishing the pertinent facts as they relate to infringement and validity. In the interest of judicial and other economies we are constrained to make the required factual collation to which we apply the legal principles resolving this dispute.

[10] The questions before the court concern the validity of Conoco's patent, U. S. Patent 3,375,800 (the '800 patent), and whether it is infringed by Cole's patent, U. S. Patent 3,931,608 (the '608 patent).[1]

A. *Factual Background*

The invention which has bred this litigation was birthed by the need to efficiently and economically locate structures beneath the ocean floor which are likely to contain oil and gas deposits. Seismic survey crews first conducted their tests on land, and later went offshore as the technology in this field advanced.

Whether on land or at sea, seismic surveys are made by electronically transmitting sound waves down into the subsurface where, on the rebound, the signals are received and recorded on surveyor's charts. The study of these charts by persons with knowledge of subterranean geological formations leads to educated adumbrations as to whether the area contains a structure which may accommodate commercial quantities of oil and gas.

In marine seismic surveying the return sound waves are received in the water above the ocean floor by instruments called hydrophones which are spaced along and

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1. We adhere to the view that determination of the validity of a patent should not be sidestepped for convenience by addressing only the infringement issue when the question of validity is raised. *See Sinclair Co. v. Interchemical Corp.*, 325 U.S. 327, 330, 65 S.Ct. 1143, 1145, 89 L.Ed. 1644 (1945) ("of the two questions [concerning validity or infringement], validity has the greater public importance"); *Beckman Instruments, Inc. v. Chemtronics, Inc.*, 428 F.2d 555, 558 n.4 (5th Cir.), *cert. denied,* 400 U.S. 956, 91 S.Ct. 353, 27 L.Ed.2d 264 (1970) ("when a challenge is made to the validity of a patent in an infringement suit, that issue should ordinarily be taken up first and infringement considered only if validity is decided favorably to the patentee").

are integral parts of a cable towed behind a survey boat. Maintaining these hydrophones at a constant depth while minimizing unwanted "noise" is essential to the accuracy of seismic readings. Prior to Conoco's paravane invention, depth was controlled primarily by attaching floats and weights to a neutrally bouyant cable. This equipment tended to create substantial noise which interfered with and distorted the return signals, markedly reducing the accuracy and usefulness of information generated. A further drawback inherent in displaying the cable by means of floats and weights, in order to maintain a constant depth, was the limitation in the area a crew could survey in a routine day. In sum, not only was the pre-paravane process slow, arduous and uncertain, but costly delays were frequently encountered.

The '800 patent claims a device co-invented by Cole while he worked for Conoco as an electrical engineer. The patent discloses a depth-sensing paravane (also called cable levelers, cable controllers or "birds") which can be attached at spaced intervals to a marine seismic cable. The paravanes take the cable to a pre-set depth and maintain that depth while the cable is under tow. The evidence is uncontroverted that the paravanes of the '800 patent were a significant step forward in the technology of marine seismography. The device not only affords precise depth control with a minimum of noise, but also greatly increases speed in use. One witness with forty years of experience in seismic surveying testified that before using the Conoco paravanes, his surveying capacity was limited to 500 miles during a two month period. With the use of Conoco's paravanes, however, this range increased to 2,000 miles. Several witnesses emphasized the improvement in the accuracy of the seismic readings resulting from the reduction in the noise previously associated with controlling the cable depth. Finally, acceptance within the seismic survey industry also reflects the value of this invention. Within a short time after the paravanes became available a majority of the marine crews throughout the world were using them, including the crews of some of the largest companies.

B. *The Patents in Suit*

In resolving the issue of the validity of the Conoco patent, and in conjunction with our review of the infringement issue, we must examine the physical function and operation of three paravanes and certain accompanying patent claims. The first, the '800 patent, was co-invented by Cole and Paul L. Buller while Cole was, as noted, employed by Conoco. The second, the '608 patent, was patented by Cole four years after he left his employment with Conoco and went into business for himself. The third paravane, relevant only insofar as it represents the state of the prior art against which the validity of the '800 patent is to be tested, is U. S. Patent 3,372,666 (the '666 patent or Baker patent) owned by Texas Instruments.

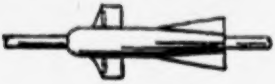
1. Conoco Patent

The Conoco patent teaches an axial bore traversing the center of the embodiment of the invention through which the seismic cable passes. In other words, the paravane is placed concentrically around the cable. Because of the cable's length, usually one to two miles, it inevitably twists and turns while under tow. To prevent this movement from spinning or flipping the paravanes, each paravane is affixed by a pair of bearings, fore and aft, which permits the cable to rotate freely. By connecting the inner race of one or both of the bearings to the cable, the paravane is prevented from moving lengthwise along the cable and thus maintains its proper spacing.

In the commercially preferred manifestation of Conoco's invention, the cable-receiving bore penetrates through the center of the paravane housing. The patent, however, also discloses alternative designs in which the bearings which form the bore for receiving the seismic cable are offset from, but parallel to, the length of the main paravane housing. The depth-sensing and regulating mechanism, several variations of which are embraced by the patent, can be interchanged in the various paravane designs.

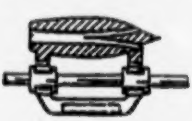
U.S. Patent 3,375,800

Conoco's commercially preferred design
with paravane housing placed
concentrically around cable.



U.S. Patent 3,375,800

Conoco's alternative design with paravane
offset from but parallel to cable.



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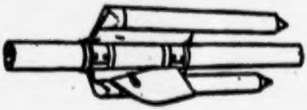
2. Cole Patent

In 1972 Cole departed his employment with Conoco. He made several efforts at developing a paravane and in 1976 secured the '608 patent which is the basis of this infringement suit. After wading through a maze of insensate semantics we are convinced that the Conoco and Cole paravanes are conceptually and functionally identical. We are notably unimpressed by the testimony of the expert offered by Cole purporting to meaningfully distinguish the two devices. Both are equipped with an internal depth-sensing mechanism connected to a pair of vanes which operates to seek and maintain a predetermined depth. Both paravanes are structured and operate to counteract upward, downward and rotational forces. Both permit the cable to rotate freely. Lastly, both limit the noise produced in accomplishing depth control and constancy.

[11] In patent validity and infringement litigation the task of discerning reticent dissimilarities is as imperative as noting the more visible similarities. In this vein we note that Cole's model dffers from Conoco's commercial version in the following respects. First, the accused paravane is offset from the cable. Second, because the paravane is offset from the cable, the rotational capability is achieved by mounting the paravane on the cable through bearings located in collars which permit free movement of the cable. Third, approximately one out of every four paravanes sold by Cole comes equipped with an upper flotation device.

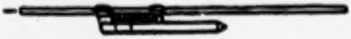
U.S. Patent 3,931,608

Cole's paravane with optional upper flotation housing.



U.S. Patent 3,931,608

Cole's paravane without upper flotation housing.



C. *Patent Validity*

[12] Relying on the Baker Patent[2] issued in 1968, and on a 1965 working model of Baker's device, Cole

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[2] Cole submits for consideration three additional patents as evidence of the prior art: Dorsey, U.S. Patent 1,625,245; Hammond, U.S. Patent 2,401,929; and Paslay, U.S. Patent 2,465,696. We find that the extent of dissimilarity between each of these patents and the '800 patent far exceeds that between the Baker and Conoco inventions. As our further discussion reflects, the degree of dissimilarity is sufficient to defeat any resort to prior art in challenging the validity of the '800 patent.

Although it may be true, as Cole contends, that a certain degree of visual similarity exists between the three earlier patents and the Conoco patent, this alone does not support a finding of similarity in structure and function. Important dissimilarities are also readily apparent—dissimilarities we find instructive in determining the prior art. The Paslay patent, for example, teaches the affixation of a drogue-type paravane at the end of the seismic cable, with an opmaintains that: (1) Conoco's paravane was anticipated by the prior art, and (2) the '800 patent claims were obvious to one ordinarily skilled in the art.[3]

1. Anticipation and the Prior Art

In 1965 Buford M. Baker, an employee of Texas Instruments, conceived a seismic cable depth-controlling apparatus (the "Baker working model"). An in-house sketch prepared for the patent department of Texas In-

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tional paravane which may be attached to the cable directly behind the boat by means of a secondary cable. Neither paravane is situated concentrically around nor rotatably attached to the seismic cable. The Dorsey drogue-type paravene similarly can only be rigidly attached to the end of a seismic cable and does not contain a bore through which the cable passes. Finally, the Hammond patent, which discloses the use of multiple apparatuses at staggered intervals along parallel cables at two different depths, refers us back to the Dorsey patent. The cables apparently are depth-controlled by a paravane located at the front of each cable. Given the above basic difference between the Conoco and the three earlier patented devices, we find it unnecessary to further explore this avenue of purported prior art.

The earlier patents raised by Cole accentuate the extent of the difficulty encountered in solving the problem of efficiently and economically gathering accurate seismic readings in water. This evidence tends to enhance the novelty of the '800 patent. *See Reynolds v. Whitin Mach. Works*, 167 F.2d 78 (4th Cir.), *cert. denied*, 334 U.S. 844, 68 S.Ct. 1513, 92 L.Ed. 1768 (1948) (21 patents cited by defendant to prove lack of novelty of plaintiffs' invention). The '800 patent solved the problem the others failed to solve.

[3] Adopting both grounds advanced by Cole, the district court intimated a finding of invalidity in the following statement:

> If plaintiff's patent claims . . . were construed as plaintiff contends . . . the claims . . . of the "800" patent in suit [would read] squarely on the Baker patent disclosure and also the prior Baker working model in evidence.

Not only is this statement unsupported by the evidence, it is inconsistent with the court's later observation that the finding of noninfringement "precludes the necessity of passing upon the issue of invalidity of Conoco's patent." The Final Judgment signed by the district judge, which Conoco states was prepared by counsel for Cole and signed over its objection, contained the reference to the invalidity of the '800 patent, an issue that apparently had not been decided.

struments contained the instruction: "Streamer [seismic cable] is free to rotate at attaching point." The invention ultimately issued as the '666 patent three years later, predating the '800 patent by less than three weeks. The rotatability feature was not part of the disclosure of the Baker patent application. Instead, the '666 patent teaches that the device is "clamped" to the cable.

[13] The defense of anticipation derives principally from 35 U.S.C. § 102(a) which provides:

> A person shall be entitled to a patent unless—(a) the invention was known or used by others in this country, or patented or described in a printed publication in this or a foreign country, before the invention thereof by the applicant. . . .

It has been held repeatedly that not only is the defense of anticipation strictly a technical one, but that unless all of the same elements or their equivalents are found in substantially the same situation where they do substantially the same work in the same way, there is no anticipation.[4] Applying this definition to the state of the prior art in the instant case, we reject Cole's contention that the '800 patent was anticipated by either the Baker working model or the subsequent '666 patent.

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[4] *See Steelcase, Inc. v. Delwood Furniture Co., Inc.*, 578 F.2d 74, 78 (5th Cir.), *cert. denied*, 440 U.S. 960, 99 S.Ct. 1503, 59 L.Ed.2d 773 (1978) ("The test for anticipation . . . requires a showing of actual identity in the prior art. . . ."); *Yoder Bros., Inc. v. California-Florida Plant Corp.*, 537 F.2d 1347, 1377 (5th Cir. 1976), *cert denied*, 429 U.S. 1094, 97 S.Ct. 1108, 51 L.Ed.2d 540 (1977); *Ziegler v. Phillips Petroleum Company*, 483 F.2d 858, 868 (5th Cir.), *cert. denied*, 414 U.S. 1079, 94 S.Ct. 597, 38 L.Ed.2d 485 (1973); *Harrington Manufacturing Co., Inc. v. White*, 475 F.2d 788 (5th Cir.), *cert. denied*, 414 U.S. 1040, 94 S.Ct. 542, 38 L.Ed.2d 331 (1973); *Van Gorp Mfg., Inc. v. Townley Industrial Plastics, Inc.*, 464 F.2d 16 (5th Cir. 1972).

[14-16] Our conclusion that the Conoco device was a breakthrough in the seismic industry and was not precursored by the Baker working model and its progeny rests on several bases. First, a presumption of validity arises from the issuance of a patent, *see Beckman Instruments, Inc. v. Chemtronics, Inc.*, 428 F.2d 555 (5th Cir.), *cert. denied*, 400 U.S. 956, 91 S.Ct. 353, 27 L.Ed. 2d 264 (1970). This is especially so in a case such as that before us where the same patent examiners simultaneously reviewed the allegedly contending applications, see *McCutchen v. Singer Company*, 386 F.2d 82 (5th Cir. 1967). *See also* 35 U.S.C. § 102(e), codifying the rule enunciated in *Milburn Co. v. Davis etc. Co.*, 270 U.S. 390, 46 S.Ct. 324, 70 L.Ed. 651 (1926) (date patent application is filed is used for the purpose of anticipating a subsequent invention). Although *McCutchen*, 386 F.2d at 85, supports the presumption of validity once a patent issues without the suggestion of interference by the Patent Office, *Beckman*, 428 F.2d at 561, goes one step further and reasons that if there is no evidence that the Patent Office considered a particular prior art, the presumption of validity is mitigated. *See also Parker v. Motorola, Inc.*, 524 F.2d 518 (5th Cir. 1975), *cert. denied*, 425 U.S. 975, 96 S.Ct. 2175, 48 L.Ed.2d 799 (1976); *Gaddis v. Calgon Corporation*, 506 F.2d 880 (5th Cir. 1975). Despite the simultaneous review by the same examiners, we shall, for present purposes, presume that the Patent Office did not consider the Baker patent before issuing the Conoco patent and subject both patents to an examination in that light.

[17] Of particular importance from Cole's viewpoint is the reference to rotatability in the Baker working model. This critical revelation soon vanishes, however, in light

of evidence indicating the intended or inadvertent suppression of the invention. Baker's description of the experimental model tested during the summer of 1965 appeared in a "Patent Disclosure Instruction and Cover Sheet' which he privately submitted to the patent department of Texas Instruments. It did not become public information. We cannot ascribe the label "prior art" to a private intracorporate communication of this nature. *See Stamicarbon, N. V. v. Escambia Chemical Corporation,* 300 F.Supp. 1209, 1215 (N.D. Fla. 1968), *aff'd as modified,* 430 F.2d 920 (5th Cir.), *cert. denied,* 400 U.S. 944, 91 S.Ct. 245, 27 L.Ed.2d 248 (1970) ("secret uses which are not publicly known or disclosed do not constitute 'prior art' under the provisions of 35 U.S.C. §§ 102 and 103").

[18, 19] We similarly reject Baker's '666 patent as prior art. Accepting *per arguendo* the contention that the rotatability feature noted in the private sketch of Baker's working model is analogous to that component of the '800 patent, imputing that similarity to the '666 patent when the patent disclosure teaches otherwise would be inappropriate. The fact that the '666 patent described the point where the paravane is attached to the seismic cable as a "clamp," rather than a rotatable apparatus, cannot be dismissed in the words of Cole's witness as "just an oversight by the patent attorney." We cannot measure the anticipatory effect of a patent by speculating as to what might have been gleaned from it. We must remain within the four corners of the patent's disclosures. *See, e.g., McCullough Tool Company v. Well Surveys, Inc.,* 343 F.2d 381 (10th Cir. 1965), *cert. denied,* 383 U.S. 933, 86 S.Ct. 1061, 15 L.Ed.2d 851 (1966); *Illinois Tool Works, Inc. v. Continental Can Company,* 273 F.

Supp. 94 (N.D. Ill. 1967), *aff'd,* 397 F.2d 517 (7th Cir. 1968).

We further note the overwhelming evidence adduced at trial reflecting not only the substandard operational capability of the Baker invention, but also the rudimentary level of technical development achieved. During experimental runs the Baker device had a tendency to oscillate, occasionally "porpoising" out of the water. In the words of Baker's supervisor, "innovative engineering" was needed to reduce the Baker concept to practice and develop it into an operationally useful device. *See United States v. Adams,* 383 U.S. 39, 50, 86 S.Ct. 708, 713, 15 L.Ed.2d 572 (1966) ("An inoperable invention or one which fails to achieve its intended result does not negative novelty."). Accordingly, we find that the prior art does not invalidate the '800 patent.

2. Obviousness

[20, 21] Cole next alleges that the '800 patent claims were obvious, thereby rendering the patent invalid under 35 U.S.C. § 103. In contrast to the defense of anticipation, which speaks only to the novelty of an invention, the defense of obviousness raises the question of inventiveness. Section 103 provides:

> A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability

> shall not be negatived by the matter in which the invention was made.

Thus, while the ultimate question of patent validity is one of law, the analytical method to be utilized by courts confronted with the question of obviousness includes basic factual inquiries into the scope and content of the prior art, the differences between prior art and the claims at issue, and the level of ordinary skill in the pertinent art. *See Graham v. John Deere Co.,* 383 U.S. 1, 86 S.Ct. 684, 15 L.Ed.2d 545 (1966); *John Zink Co. v. National Airoil Burner Co.,* 613 F.2d 547 (5th Cir. 1980).

[22] A substantial portion of our prior discussion concerning anticipation by the prior art is pertinent in resolving the question of obviousness. Because of the novelty-inventiveness dichotomy, however, prior art may result in an invention being obvious even though not anticipated. *See e.g., Harvey v. Levine,* 322 F.2d 481 (6th Cir. 1963); *Amphenol Corporation v. General Time Corporation,* 397 F.2d 431 (7th Cir. 1968).

[23] The linchpin is not whether the individual components of the '800 patent were obvious at the time of the invention, but whether the aggregation produced a new or different result or achieved a synergistic effect. *See Ingersoll-Rand Company v. Brunner & Lay, Inc.,* 474 F.2d 491, 496 (5th Cir.), *cert. denied,* 414 U.S. 865, 94 S.Ct. 125, 38 L.Ed.2d 117 (1973). *See also Adams v. United States,* 380 F.2d 622, 625, 165 Ct. Cl. 576 (1964), *aff'd,* 383 U.S. 39, 86 S.Ct. 708, 15 L.Ed. 2d 572 (1966) ("While the use of any of the individual components . . . may have been obvious at the time of the invention, the invention *as a whole* was not obvious. . . ."). In addition to the several patents Cole raised

which we have noted above as non-dispositive, the remaining semblance of prior art against which the '800 patent must be compared is the Baker patent. As previously recognized, the Baker patent does not teach utilization of a rotatable seismic cable. It is also evident that Baker and other Texas Instrument employees involved in the invention possessed not only ordinary, but most likely extraordinary skill in the art. Yet by the time Conoco obtained the '800 patent in 1968, Baker and his co-workers had spent over three years trying unsuccessfully to produce a functional paravane.[5]

[24] Having compared the Conoco paravane with the prior art, we are convinced that the creative process existing prior to issuance of the '800 patent was in an embryonic stage. It would be manifestly unjust to characterize the '800 patent as anything other than innovatively different and not readily obvious to a person of ordinary skill in the field of marine seismology. We find the '800 patent valid and proceed to assay the district judge's holding that the '608 patent did not infringe.

D. Infringement

The final issue is whether Cole's '608 patent infringes Conoco's '800 patent. The allegation stems from five claims of the '800 patent, numbers 1, 2, 4, 22 and 25, the most controversial and inclusive of which reads in part:

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[5] The contemporaneous failures of those who are experts in the art tend to indicate that an invention is not obvious. *See e.g., Illinois Tool Works, Inc. v. Continental Can Company,* 397 F.2d 517 (7th Cir. 1968). The failures experienced by the Baker group were not mere construction infirmities requiring only slight modifications, but were design defects requiring innovative engineering.

> 1. A paravane . . . comprising: a housing having a bore means along its length thereof. . . .

The parties to this case as well as the district judge put much emphasis on the interpretation to be accorded this language. We do not find a *strictissimi* interpretation necessary given the liberal construction warranted by the doctrine of equivalents.

[25, 26] We accept the finding of the district court that sufficient differences exist between the Conoco and Cole inventions to avoid literal infringement. We underscore, however, that it is precisely because "minor modifications are . . . sufficient to avoid literal infringement," *Weidman Metal Masters v. Glass Master Corp.*, 623 F.2d 1024, 1026 (5th Cir. 1980), that the protection afforded patentees by the doctrine of equivalents must not be emasculated by too quick a stroke of the judicial pen.[6]

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[6] Recognizing the important role played by the doctrine of equivalents in protecting patent claims from the enterprising minor deviations of invention "pirates," the Supreme Court in *Graver Mfg. Co. v. Linde Co.*, 339 U.S. 605, 607, 70 S.Ct. 854, 855-56, L.Ed. 1097 (1950), stated:

> In determining whether an accused device or composition infringes a valid patent, resort must be had in the first instance to the words of the claim. If accused matter falls clearly within the claim, infringement is made out and that is the end of it.
>
> But courts have also recognized that to permit imitation of a patented invention which does not copy every literal detail would be to convert the protection of the patent grant into a hollow and useless thing. Such a limitation would leave room for—indeed encourage—the unscrupulous copyist to make unimportant and insubstantial changes and substitutions in the patent which, though adding nothing, would be enough to take the copied matter outside the claim, and hence outside the reach of law. One who seeks to pirate an invention, like one who seeks to pirate a copyrighted book or play, may be expected to introduce minor variations to conceal and shelter the piracy. Outright and forthright duplication is a dull and very rare type of infringement. To prohibit no other would place the inventor at the mercy of verbalism and would be subordinating substance to form. It

1. Doctrine of Equivalents

[27, 28] We are cognizant that a finding of equivalence is a determination of fact. *Ziegler v. Phillips Petroleum Company,* 483 F.2d 858 (5th Cir.), *cert. denied,* 414 U.S 1079, 94 S.Ct. 597, 38 L.Ed.2d 485 (1978). In this case, however, the breadth of the doctrine of equivalents is a question of law because it concerns the construction of the '800 patent. *See Coupe v. Royer,* 155 U.S. 565, 15 S.Ct. 199, 39 L.Ed. 263 (1895). Our perception of the doctrine of equivalents is best expressed by this Supreme Court teaching:

> What constitutes equivalency must be determined against the context of the patent, the prior art, and the particular circumstances of the case. Equivalence, in the patent law, is not the prisoner of a formula and is not an absolute to be considered in a vacuum. It does not require complete identity for every purpose and in every respect. In determining equivalents, things equal to the same thing may not be equal to each other and, by the same token, things for most purposes different may sometimes be equivalents. Consideration must be given to the purpose for which an ingredient is used in a patent, the equalities it has when combined with the other ingredients, and the function which it is intended to perform.

Graver Mfg. Co. v. Linde Co., 339 U.S. 605, 609, 70 S.Ct. 854, 856, 94 L.Ed. 1097 (1950). Once the framework for determining equivalency had been erected, it becomes readily apparent that the Cole device has infringed the range of equivalents of the '800 patent.

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would deprive him of the benefit of his invention and would foster concealment rather than disclosure of inventions, which is one of the primary purposes of the patent system.

2. File wrapper estoppel

[29] Finally, we address the applicability of the doctrine of file wrapper estoppel. This doctrine prevents a patentee from reclaiming through the doctrine of equivalents that which was voluntarily surrendered by the narrowing of the language of the patent claims in order to avoid prior art cited by the Patent Office. The district judge concluded the doctrine applies. We disagree, being of the opinion that the range of equivalents has not been so limited as to preclude a finding of infringement by the Cole patent.

[30] The original application for the '800 patent was filed in December 1966 and embraced only the commercially preferred design with the paravane placed concentrically around the seismic cable. In April 1967, a continuation-in-part application was filed which included other manifestations of the invention. The district judge concluded that the original claims were broad enough to cover the accused device, but that the continuation-in-part constituted a disclaimer which now estops Conoco from asserting that which it previously surrendered. We reject the district judge's conclusion for three reasons. First, in *Hunt Tool Company v. Lawrence,* 242 F.2d 347 (5th Cir.), *cert. denied,* 354 U.S. 910, 77 S.Ct. 1296, 1 L.Ed.2d 1428 (1957), we noted that a patent applicant is not presumed to have narrowed his claim more than was necessary to satisfy the Patent Office's challenge. Second, in the case before us, there is no evidence in the file history that the Conoco application was amended because of the Patent Office's rejection based on prior art. Third, because the '800 invention solved a sophisticated and stubborn problem in the field of marine seismology,

which had long remained unresolved despite vast research and development efforts conducted over a number of years, a broader degree of protection is to be afforded under the doctrine of equivalents than that ascribed by the district judge.[7]

Cole contends that on the basis of file wrapper estoppel, his '608 patent does not infringe the following language of Claim No. 1 of the '800 patent: "a housing having a bore means along its length thereof." He emphasizes that the *housing* structure of the '608 paravane does not *have* a bore means (that portion of the paravane that receives and allows rotation of the cable) along its length. His argument rests largely on the trial judge's finding that the collars securing the main body of the paravane to the cable do not constitute part of the housing. Were we to agree that the doctrine of equivalents is to be narrowly applied it would be necessary to carefully analyze these terms. Because we hold that broad protection is to be accorded the '800 patent claims we find it unnecessary to engage in that exercise.

The '800 and '608 patents involve more than a similarity in result. The evidence "establish[es] substantial identity of means, operation and result." *Foster Cathead Company v. Hasha*, 382 F.2d 761, 765 (5th Cir. 1967), *cert. denied*, 390 U.S. 906, 88 S.Ct. 819, 19 L.Ed.2d

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[7] We do not go so far as to classify the '800 patent as a pioneer, *i.e.* "a patent covering a function never before performed, a wholly novel device, or one of such novelty and importance as to mark a distinct step in the progress of the art," but neither do we consider the invention to be "a mere improvement or perfection of what had gone before." *Westinghouse v. Boyden Power Brake Co.*, 170 U.S. 537, 561-62, 18 S.Ct. 707, 718, 42 L.Ed. 1136 (1898). The '800 patent falls someplace in between, as does the measure of protection to be afforded to it.

872 (1968), *quoting* C. Pigott, Equivalents in Reverse, 43 Journal of the Patent Office Society 291-92 (1966). The '608 patent infringes the '800 patent.

The decision of the district court is REVERSED. We hold that Conoco's patent, U.S. Patent 3,375,800 is valid and that it is infringed by Cole's patent, U.S. Patent 3,931,608. The case is REMANDED for further proceedings consistent with this opinion.

REVERSED, RENDERED and REMANDED.

PETITIONERS' SUBSTITUTION APPENDIX B

IN THE UNITED STATES DISTRICT COURT FOR THE SOUTHERN DISTRICT OF TEXAS HOUSTON DIVISION

CIVIL ACTION NO. H-75-1288

CONTINENTAL OIL COMPANY

v.

JIMMY R. COLE, D/B/A JIM R. COLE & ASSOCIATES AND COLE DEVELOPMENT COMPANY, INC.

MEMORANDUM

Plaintiff, Continental Oil Company ("Conoco") sues for infringement under the Patent Laws of the United States, Title 35 U.S.C. against Jimmy R. Cole, d/b/a Jim R. Cole & Associates ("Cole") and Cole Development Company, Inc. ("Cole Development"). This Court has jurisdiction of the parties and of the subject matter of this action by virtue of U.S.C. § 1338 and § 2201. Venue is properly laid in this district under Title 28 U.S.C. § 1406(b). Defendant Cole alleges that plaintiff's patent is invalid and alternatively that defendant's patent does not infringe.

Defendant, while an employee of plaintiff, obtained Patent No. 3,375,800 (hereinafter the "800" patent). The "800" patent is a device for maintaining an underwater seismic cable at a constant depth while being towed by a ship. After leaving, Conoco, defendant obtained Patent No. 3,931,608 (hereinafter the "608" patent) on an improved underwater cable water controller, which device is the alleged infringing apparatus. Defendants' manufacture and sell two models of their cable depth controllers, one of which is shown in Fig. 1 of defendants' United States Patent 3,931,608, and the other of which is shown in Fig. 3 of the same patent. The difference between the two models is that the Fig. 3 model includes an additional flotation tube assembly T. The evidence shows that a vast majority of the defendants' cable depth controllers which have been manufactured and sold are of the type shown in Fig. 1 of U. S. Patent 3,931,608, in which the housing H is located to one side of the streamer or cable K.

Plaintiff claims that defendants wilfully infringed five claims of the "800" patent by the manufacture and sale of a seismic depth control appartus and, further, that defendants induced the purchasers of the accused apparatus to use it in an infringing manner. The claims of the "800" patent on which Conoco asserts infringement read as follows:

> 1. A paravane for a seismic cable adapted to be towed substantially horizontally through water, comprising: a housing having a bore means along its length thereof, said bore means of a size to receive said seismic cable and allow rotation of said seismic cable without rotation of said housing while transmitting upward and downward forces between the housing and the adjacent portions of said cable; bearing means for securing the housing onto said seismic cable against movement of said housing along said cable; and means carried by the housing including at least one vane for maintaining the para-

vane at a predetermined depth in the water as the paravane is moved through the water by the cable and for counteracting upward, downward and turning forces imposed on the housing, whereby the paravane maintains the adjacent portions of the said seismic cable at said predetermined depth.

2. A paravane as defined in Claim 1 wherein said last mentioned means includes: ballast carried by the housing below the cable to counteract turning forces imposed on the housing; depth sensing means carried by the housing; and adjustable diving means carried by the housing, engaging the water and connected to the depth sensing means for varying the depth of the paravane in response to the depth sensing means.

4. A paravane as defined in claim 2 wherein said adjustable diving means comprises: diving plans rotatably secured to the opposite sides of the housing; and means interconnecting the diving planes for uniform adjustment of the diving planes in response to the depth sensing means.

22. Apparatus for maintaining a seismic cable at a predetermined depth as the cable is being towed substantially horizontally through water, comprising: a plurality of paravanes secured in spaced relation along the cable, each of said paravanes comprising: a housing having a bore means along its length thereof, said bore means of a size to receive said seismic cable and allow rotation of said cable without rotation of said housing while transmitting upward and downward forces between said housing and adjacent portions of said cable; bearing means

for securing said housing onto said cable against movement of said housing along said cable; and means carried by the housing including at least a vane for maintaining the paravane at a predetermined depth in the water as the paravane is moved through the water by the cable and for counteracting upward, downward and turning forces imposed on the housing, whereby the paravane maintains the adjacent portion of the cable at said predetermined depth.

25. A paravane for an elongated member adapted to be towed substantially horizontally through water, comprising: a housing having a bore means along its length thereof, said bore means of a size to receive said elongated member and allow rotation of said elongated member without rotation of said housing while transmitting upward and downward forces between the housing and the adjacent portions of said elongated member; bearing means for securing the housing onto said elongated member against movement of the housing along said elongated member; and, means carried by the housing including at least a vane for maintaining the paravane is moved through the water by said member and for counteracting upward, downward and turning forces imposed on the housing, whereby the paravane maintains the adjacent portion of said predetermined depth.

Defendants maintain first that the "800" patent is invalid for obviousness. Secondly, as the five claims of the "800" patent in suit cannot be construed to describe either model of cable depth controller that defendants sell, defendants have not infringed the "800" patent.

Thirdly, the file history of the "800" patent and the amendments made to seccure the patent create a "file wrapper estoppel" which prevents plaintiff from now contending that these claims cover defendants' device.

Collateral to the issue of non-infringement are several purely legal issues raised by defendant Cole: (1) there exists an implied royalty-free license to manufacture and sell defendants' devices since plaintiff has granted licensed users of cable depth controllers the unrestricted right to have such depth controllers made by others, (2) with respect to acts performed outside the territorial limits of coverage of the United States Patent Laws, there can be no infringement and (3) plaintiff's alleged knowledge of material and relevant prior art and its failure to disclose such art to the Patent Examiner during the prosecution of the patent in suit renders this an exceptional case under 35 U.S.C. 285 entitling defendants to an award of their attorneys fees.

The "800" patent is a combination patent, i.e. it is a patent in which all of the individual elements are old and the asserted novelty resides in the combination of those elements. The patent must be strictly confined to the particular combination claimed. Patents on a simple combination of known mechanical elements, such as the patent in suit, are difficult to obtain and they are not easily infringed. *Foster v. Hasha,* 382 F.2d 761, 766 (5th Cir. 1967). For plaintiff to sustain a charge of infringement by defendant, defendant's tools must include all elements explicitly recited in the claim. Omission of a single element in such a claim clearly avoids infringement. *Deepsouth Packing Co. v. Laitram Corp.,* 406 U.S. 518 (1972); *Marvin Glass v. Sears,* 448 F.2d 60, 61 (5th Cir. 1971).

In addition to direct infringement, there can be infringement under the doctrine of equivalents. This doctrine must be applied narrowly to the particular simple combination patent claimed because they are difficult to obtain and should be sustained. *Hughes v. Magnolia Petroleum Co.*, 88 F.2d 817, 33 (5th Cir. 1937); *Stewart-Warner Corp. v. Lone Star Gas Co.*, 195 F.2d 645 (5th Cir. 1952); *Sisko v. Southern Resin and Fiberglass Corporation*, 248 F.Supp. 797, (S.D. Fla. 1965), aff'd 373 F.2d 866 (5th Cir. 1967).

To establish equivalency for the purpose of showing infringement of the five claims of plaintiff's patent by defendant, plaintiff must prove that defendant's tools are substantially identical with the arrangement defined in the claim as to structure, mode of operation and results attained. *Ziegler v. Phillips Petroleum Co.*, 483 F.2d 858, 868 (5th Cir. 1973); *Harrington Manufacturing Co., Inc. v. White*, 475 F.2d 788, 796 (5th Cir. 1973), *cert. denied*, 38 L.Ed.2d 331 (1973); *Marvin Glass & Associates v. Sears, Roebuck and Company*, 448 F.2d 60, 61 (5th Cir. 1971).

However, before plaintiff may reach the question of equivalency, he must deal with limitations imposed upon his own patent under the doctrine of file wrapper estoppel. An invention is construed not only in the light of its claims, but also with reference to its file wrapper or prosecution history in the Patent Office. *Ziegler v. Phillips Petroleum Company*, 483 F.2d 858, 870 (5th Cir. 1973). After prosecution of his patent, an applicant is precluded by the doctrine of file estoppel from thereafter ignoring restrictive terminology added to the patent and attempting by the doctrine of equivalents to interpret the claims as though the limitations were not present. *Graham v. John Deere Co.*, 383 U.S. 1, 33 (1966); *Schriber Co. v. Cleveland Trust Co.*, 311 U.S. 211, 220-1, (1940); *Weber Electric Co. v. Freeman Electric Co.*, 256 U.S. 668, 677 (1920); *Smith v. Magic City Kennel Club*, 282 U.S. 784, 789 (1930); *Ziegler v. Phillips Petroleum Co.* 483 F.2d 858, 870 (5th Cir. 1973). The doctrine of file wrapper estoppel applies whether the restriction added subsequent to application to the Patent Office were proposed by the Patent Examiner or the applicant. *Dry Hand Mop Co. v. Squeez-egy Mop Co.*, 17 F.2d 465, 466 (5th Cir. 1927).

The file wrapper of plaintiff's patent in suit reveals that the only claims broad enough to cover defendants' structure were cancelled and replaced by more limited claims. Each of the structural differences between defendants' structure and plaintiff's claims in suit were a result of amendatory language submitted during prosecution of plaintiff's patent in suit in the Patent Office. Accordingly, as a matter of law under the doctrine of file wrapper estoppel, plaintiff cannot now assert that the amended claims cover what has been eliminated from coverage during prosecution before the Patent Office.

The broadest claim of the "800" patent which is asserted in this litigation is claim 1. The following elements of Claim 1 have not been included in the defendants' model Fig. 1 or defendants' model Fig. 3:

> (a) Defendants' device does not have "a housing having a bore means along its length." This is because the dictionary definition of "housing" is "in mechanics, a frame, box, etc. for containing some part." The only "housing" in the defendants' cable depth controllers is the housing H shown in Figs. 1

and 3 of U. S. Patent 3,931,608, but it does not have "a bore means along its length" as required by Claim 1. Therefore, the structure, "a housing having a bore means along its length", cannot be found in defendants' cable depth controllers.

(b) The collars 20 of the defendant's device cannot be considered a "housing" in accordance with the dictionary definition because they are not for "containing some part".

(c) There is no "bearing means for securing the housing onto said seismic cable" in the defendants' cable depth controller because the housing does not have any bearing means in defendants' cable depth controllers.

(d) The vanes P of the defendants' cable depth controller are not carried by the housing H, but instead are mounted on a separate body S which is attached to the housing H and therefore defendants' cable depth controllers do not have the "means carried by the housing including at least one "vane as recited in Claim 1.

Since the other claims have more elements than Claim 1 and since each of the other claims, 2, 4, 22, and 25 have the foregoing elements which are not found in defendants' cable depth controllers, none of the claims, 1, 2, 4, 22 and 25 of the "800" patent in suit are infringed by defendants' cable depth controllers.

Although the model shown in Fig. 3 of defendants' patent 3,931,608 may look more like the plaintiff's cable depth controller of the "800" patent in suit than the Fig. 1 model of U. S. Patent 3,931,608, the evidence is that the flotation device T is only added in a very limited number of cases and could be omitted entirely, but it does not add any additional element which would cause the

Fig. 3 model of defendants' cable depth controller to come within the claims 1, 2, 4, 22 and 25 of the "800" patent in suit.

If plaintiff's patent claims 1, 2, 4, 22 and 25 were construed as plaintiff contends so that the collars 20 of defendants' cable depth controllers were considered as the "bore means" of the housing H, such conclusion would necessarily lead to a reading of the claims 1, 2, 4, 22 and 25 of the "800" patent in suit squarely on the Baker patent disclosure and also the prior Baker working model in evidence.

In view of the above factual determination, this Court finds that neither of defendants' devices infringe the "800" patent. Such finding precludes the necessity of passing upon the issue of invalidity of Conoco patent. The Court further finds that this is not an exceptional case under 35 U.S.C. § 285 by virtue of misrepresentation to the Patent Office. Therefore, defendant Cole is not entitled to attorney's fees under 35 U.S.C. § 285.

Defendants' attorney will draft a judgment in accordance with the memorandum opinion for submission to this Court.

Signed at Houston, Texas, this 8th day of March, 1978.

/s/ ROBERT O'CONOR, JR.
Robert O'Conor, Jr.
United States District Judge

PETITIONERS' SUBSTITUTION APPENDIX C

UNITED STATES COURT OF APPEALS
Fifth Circuit

DENIALS OF REHEARING EN BANC

(Rule 35 Federal Rules of Appellate Procedure; Local Fifth Circuit Rule 12)

Group 1—Denials where no member of the panel nor Judge in regular active service on the Court requested that the Court be polled on rehearing en banc.

Group 2—Denials after a poll requested by a member of the panel or a Circuit Judge in regular active service.

Group 3—Denials on the Court's own motion after a poll requested by a member of the panel or a Circuit Judge in regular active service.

Title GROUP 1	Docket Number	Date of Denial	Citation of Panel Decision
Baker v. Metcalfe	80-1626	2/17/81	N.D.Tex., 633 F.2d 1198
Concerned Democrats of Florida v. Reno	80-5482	2/ 9/81	S.D.Fla., 634 F.2d 629
Continental Oil Co. v. Cole	78-1961	2/12/81	S.D.Tex., 634 F.2d 188
Palaez Del Casal v. Eastern Air Lines, Inc.	79-2953	2/18/81	S.D. Fla., 634 F.2d 295
U. S. v. Chagra	80-1506	2/ 2/81	W.D. Tex., 636 F.2d 311
U. S. v. McCain	79-5577	2/ 6/81	S.D.Fla., 633 F.2d 581

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No. 80-2037

IN THE

Supreme Court of the United States

OCTOBER TERM, 1980

JIMMY R. COLE, d/b/a JIM R. COLE & ASSOCIATES and COLE DEVELOPMENT COMPANY, INC.,

Petitioners,

VERSUS

CONTINENTAL OIL COMPANY,

Respondent.

RESPONDENT'S BRIEF IN OPPOSITION

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Abbreviations

P. : Petition for Writ of Certiorari

P.App. : Appendix to Petition for Writ of Certiorari

No. 80-2037

IN THE

Supreme Court of the United States

OCTOBER TERM, 1980

JIMMY R. COLE, d/b/a JIM R. COLE & ASSOCIATES and COLE DEVELOPMENT COMPANY, INC.,

Petitioners,

VERSUS

CONTINENTAL OIL COMPANY,

Respondent.

ON PETITION FOR A WRIT OF CERTIORARI TO THE UNITED STATES COURT OF APPEALS FOR THE FIFTH CIRCUIT

RESPONDENT'S BRIEF IN OPPOSITION

Respondent Continental Oil Company ("Conoco") agrees that this Court has jurisdiction to consider Jimmy R. Cole *et al.'s* ("Cole") petition for writ of certiorari under 28 U.S.C. § 1254(1). It disagrees, however, that the petition presents any question meriting this Court's review.

This case involves no novel or controversial issue of law. The court below reversed the district court's holding of non-infringement and held a patent issued to Cole, while an employee of Conoco, to be valid and infringed by Cole, who subsequently had gone into business for himself. Petitions for rehearing and rehearing *en banc* were also denied. *Continental Oil Co.* v. *Cole,* 634 F.2d 188, *rehearing denied,* 638 F.2d 1234 (5th Cir. 1981).

On May 22, 1981 Cole agreed to the entry of an injunction prohibiting the manufacture and sale of the patented devices except to fill orders by Conoco's licensees.

The legal standards applied by the court of appeals were fully in compliance with prevailing constitutional, statutory and judicial precepts. In his petition, Cole seeks merely to reargue the facts. He has presented no sound reason why this Court should entertain such request.

The petition for writ of certiorari should be denied.

REASONS FOR DENYING THE PETITION

Cole objects to the court of appeals' decision because the court explicitly held the patent in suit valid over a prior art patent and a related "private intracorporate communication" which "did not become public information" and a related experiment which reflected "substandard operational capability". *Continental Oil Co.* v. *Cole,* 634 F.2d at 195-196. Petitioners also refer to another prior art patent (Reid) which neither the trial court nor the court below even discussed. The argument is couched in terms of an alleged misinterpretation of an important Federal statute involving the validity of patents and a perceived conflict with various decisions of this Court. The petition is devoid of support for either contention.

Petitioners Merely Seek to Reargue Factual Issues

The patent claims a device useful in marine geophysical surveying of underground formations for the possible presence of oil and gas. The device is rotatably attached at intervals to a long sensing cable towed behind a boat during a survey. It maintains the cable at a constant water depth thereby vastly improving the quality of the data. The invention was made by petitioner Cole while employed by Conoco, and has enjoyed remarkable commercial success. Cole subsequently left Conoco and started his own business of manufacturing cable depth controllers. When sued for infringement of the patent, he contended that his patent was invalid and that he had not infringed it.

The district court rendered a decision for Cole without making proper findings. The court of appeals reversed and rendered a decision that the patent was valid and infringed. The decision is based on the court's review of the record which it found "replete with evidence fully establishing the pertinent facts as they relate to infringement and validity." *Continental Oil Co.* v. *Cole,* 634 F.2d at 191.

Cole now argues (P. 4-5, 7, 9) that the court of appeals failed to give due consideration to U.S. patent No. 3,372,666 to Baker (P. App. E), the internal research activities by Baker (P. App. F), and U.S. patent No. 2,607,842 to Reid (P. App. G). All of these were part of the record in the district court and the court of appeals. They did not lead to the invalidation of the patent in suit because they were not prior art and/or did not disclose the patented invention. The court below specifically held that the Baker patent did not disclose rotatability of a controller around the cable, 634 F.2d at 196, and that the internal research records did not constitute prior art, *id.* at 195-96. The decision does not even refer to the Reid patent, presumably because it was even less pertinent than the Baker patent.

All of petitioners' arguments were made to and rejected by the court of appeals. There is no reason why this Court should entertain a reargument of the factual issues resolved below.

The Decision Below Is Consistent With Applicable Legal Standards

It is difficult to understand exactly where petitioners contend the court of appeals went wrong in its obviousness analysis under 35 U.S.C. § 103. The court meticulously applied the standards set forth in *Graham* v. *John Deere Co.,* 383 U.S. 1 (1966). It posed the ultimate issue, as follows:

> The linchpin is not whether the individual components of the '800 patent were obvious at the time of invention, but whether the aggregation produced a new or different result or achieved a synergistic effect. [*Continental Oil Co.* v. *Cole,* 634 F.2d at 197.]

The emphasis on looking at the combination of the individual elements rather than the individual elements themselves is supported by a number of other decisions by this Court. In a footnote to a case considering what is patentable subject matter under 35 U.S.C. § 101, this Court acknowledged that "Section 103, by its own terms, requires that a determination of obviousness be made by considering 'the subject matter as a whole.'" *Parker* v. *Flook,* 437 U.S. 584, 594, n. 16 (1978). And in *Anderson's-Black Rock, Inc.* v. *Pavement Salvage Co.,* 396 U.S. 57 (1969), the Court stated: "The question of invention must turn on whether the combination supplied the key requirement." *Id.* at 60. Finally, in *Sakraida* v. *AgPro Inc.,* 425 U.S. 273 (1976) this Court found a combination patent invalid because the combination "did not produce a new or different function. . .", *id.* at 282. The decision of the court below is fully in accordance with accepted statutory and judicial principles.

The argument that the court of appeals was swayed by the patent's commercial success in its finding of non-obviousness is purely speculative. In determining obviousness, the court below used the proper *Graham* analysis; it placed no explicit reliance on the fact that the invention was a great commercial success. But assuming that it had, as this Court noted in *Graham*, commercial success may be a secondary consideration indicative of nonobviousness. *Graham, supra,* 383 U.S. at 17-18.

Cole also ascribes error to the rejection by the court below of the internal Baker research documents (P. App. F) as prior art. The appellate court's decision was not premised on the view that a commercially marketable device must be developed before a prior invention by another constitutes prior art. Rather, the court noted that the Baker research had been suppressed and did not become public information. *Continental Oil Co.* v. *Cole,* 634 F.2d at 195-96. Rejection of unpublished information as prior art under such circumstances is totally in accordance with well settled law. *See, e.g., Corona Cord Tire Co.* v. *Dovan Chemical Corp.,* 276 U.S. 358, 372-374 (1928); *Stamicarbon, N.V.* v. *Escambia Chemical Corp.,* 300 F.Supp. 1209, 1215 (N.D. Fla. 1969), *aff'd as modified,* 430 F.2d 920 (5th Cir.), *cert. denied,* 400 U.S. 944 (1970). The court referred to the failure of the secret Baker device as supportive of its conclusion that the invention of the patent in suit was an unobvious, patentable advance. 634 F.2d at 196, 197.

The court below employed the applicable statutes and prior decisions in a carefully reasoned, routine, and noncontroversial fashion. All of the legal theories applied are well settled, and none is in conflict with any opinion of this Court or any court of appeals.

This is a routine patent case that was decided on its facts, with no novel or important points of law at issue. No valid reason has been advanced why this Court should review the decision below. The petition for writ of certiorari should be denied.

CONCLUSION

For the reasons stated above, Respondent respectfully requests that the petition for writ of certiorari be denied.

Respectfully submitted,

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CERTIFICATE OF SERVICE

I hereby certify that three copies of the above Respondent's Brief in Opposition have this date been served upon opposing counsel of record by placing same in the United States Mail, postage prepaid and properly addressed.

C. Frederick Leydig

July 27, 1981

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ALEXANDER L. STEVAS,
CLERK

NO. 80-2037

IN THE

Supreme Court of the United States

OCTOBER TERM, 1980

JIMMY R. COLE, d/b/a JIM R. COLE &
ASSOCIATES and COLE DEVELOPMENT
COMPANY, INC.
Petitioners,

v.

CONTINENTAL OIL COMPANY, INC.,
Respondent.

ON PETITION FOR A WRIT OF CERTIORARI TO THE UNITED STATES COURT OF APPEALS FOR THE FIFTH CIRCUIT

PETITIONERS' REPLY BRIEF

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ON PETITION FOR A WRIT OF CERTIORARI TO THE UNITED STATES COURT OF APPEALS FOR THE FIFTH CIRCUIT

PETITIONERS' REPLY BRIEF

Petitioners', Cole, et al., addressing arguments[1] first raised in Respondent, Continental Oil Company's (Conoco), Brief in Opposition, file this Reply Brief.

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[1] Petitioner would point out that the agreed entry of injunction pending review by this Court mentioned by Conoco was subsequent to, and caused in good part by, the denial of Petitioners' Motion to Stay Mandate on Feb. 25, 1981.

THE COURT OF APPEALS APPLIED AN ERRONEOUS PATENT VALIDITY STANDARD GREATLY EXPANDING THE PERMISSIBLE GROUNDS FOR PATENT MONOPOLY.

Petitioners seek review of an egregious error by the Fifth Circuit Court of Appeals as to the standard of patentability under 35 U.S.C. § 103. No mere reargument of factual issues is sought by petitioners. A substantial issue as to what may be appropriated as a patent monoply is represented to this Court for review. Simply put, may a court find a patent valid based on features known to the Patent Office in issuing the patent?

The appellate court decision below, *Continental Oil Co. v. Cole,* 634 F.2d 188 (5th Cir. 1981) sought to be reviewed here gives, at best, lip service to the standard of patent validity of non-obviousness under 35 U.S.C. § 103 of *Graham v. John Deere Co.,* 383 U.S. 1 (1966). Mention is made, in passing only, that a determination of patent validity under 35 U.S.C. § 103 requires an inquiry into the three factors[2] first set forth in *Graham,* supra, in determining obviousness under 35 U.S.C. § 103. *Continental Oil Co. v. Cole,* supra at 196. The Fifth Circuit opinion makes no mention of the progeny of *Graham* in this Court dealing with the standard of patentability under 35 U.S.C. § 103: *Anderson's-Black Rock, Inc. v. Pavement Salvage Co.,* 396 U.S. 57 (1969); *Sakraida v. AgPro, Inc.,* 425 U.S. 273 (1976); and *Dann v. Johnston,* 425 U.S. 219 (1976).

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[2] Scope and content of prior art, Differences between claims and prior art, and Level of ordinary skill in the art.

The appellate court's decision sought to be reviewed here can be construed to read the standards of 35 U.S.C. § 103 repeatedly enunciated by this Court out of the law, since courts and one of ordinary skill in the art are precluded from considering the effect of a patent "by speculating what might be gleaned from it." *Continental Oil Co. v. Cole,* supra at 196. This, however, is exactly what courts must do in determining patent validity under *Graham,* where: "The emphasis on nonobviousness is one of inquiry . . ." *Graham,* 383 U.S. 1, 17.

THE "LINCHPIN" OF ROTATABILITY WAS KNOWN PRIOR TO CONOCO

The Fifth Circuit's alleged "linchpin" of its decision is that the Baker reference, U.S. Patent No. 3,372,666 (P.App. E) did not teach the utilization of a "rotatable seismic cable". *Continental Oil Co. v. Cole,* 634 F.2d at 197. In seizing the "linchpin", the appellate court disregarded an important point—the feature of rotatability of a depth controller connection to a seismic cable, as shown in Reid, U.S. Patent No. 2,607,842 (P.App. G), was known and cited by the Patent Office Examiner (See P.App. D-10) who issued the Conoco '800 patent.

Conoco attempts, however, to have this Court ignore Reid because it was not mentioned by either of the courts below. The trial court did not discuss the Reid rotation feature since it decided there was no infringement and did not reach the issue of the invalidity of the Conoco '800 patent. The major reason that review of the appellate court decision is sought here by Petitioners is that the rotatability feature of Reid was ignored in the Fifth Circuit.

Rotatability, indeed, was not even unique to Reid prior to Conoco, since it was known to Baker (P.App.F) prior to Conoco. Not only are the Baker documents and the Baker working device prior art under 35 USC § 102, but they are clearly available under 35 USC § 103 as additional teachings that rotatability of the seismic cable depth controller connection was well within the level of ordinary skill in the art.[3]

SUMMARY

This petition does not involve a reargument of facts. It involves an appellate court's ignoring of the strict standard of patentability under 35 USC § 103 repeatedly enunciated by this Court. If the appellate court decision is permitted to stand as precedent, courts could ignore known prior art and deprive the public of the use of that prior art teaching in holding a patent valid. In this case, the prior art is in the form of the expired Reid patent, which shows the appellate court's alleged "linchpin" of a rotatably connected seismic cable depth controller. The Fifth Circuit decision can be viewed as carefully reasoned (as Conoco urges) only by wearing blinders and using tunnel vision to ignore the teachings of the Reid patent and the work of Baker.

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3. The issues of "suppression" and alleged unpublished information are also *legal* issues of extreme importance. For example, can there be *unintentional* suppression under 35 USC 102 as the Court held below? Are not prior *unpublished* documents fully disclosing the "linchpin" pertinent for a Court to consider on the issue of "obviousness" under 35 USC § 103? See, e.g., *Beckton, Dickinson & Co. v. Sherwood Medical Industries, Inc.*, 516 F.2d 514, 521 (5th Cir. 1975).

Accordingly, for reasons set forth above and in the Petition for Writ of Certiorari, it is respectfully submitted that a Writ of Certiorari should be granted.

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I hereby certify that three copies of the foregoing Petitioners' Reply Brief to Respondent's Brief in Opposition have been this date served on opposing counsel by placing same in the United States Mail, postage prepaid and properly addressed.

ALBERT B. KIMBALL, JR.